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TELEPHONE ENGINEER

VOLUME 27 FEBRUARY, 1923 Number 2

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—Quill Pens for Correspondence?
—or Stage Coaches for Travelling?

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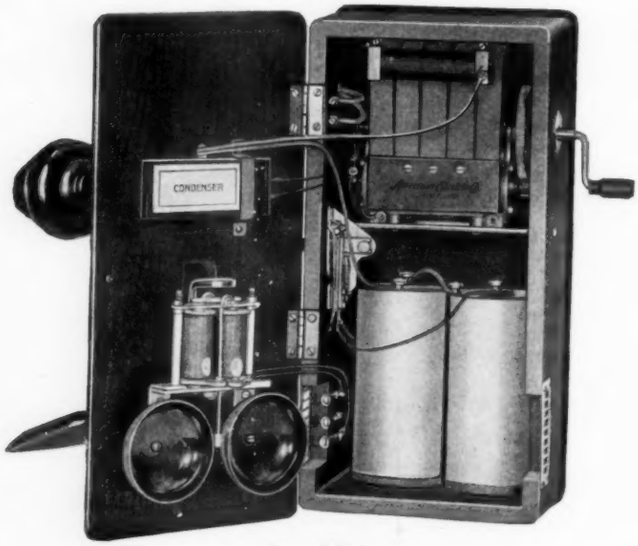

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American Electric Company

CHICAGO, U. S. A.

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VOLUME 27 FEBRUARY, 1923 Number 2

When Ice Breaks the Poles

Excessive Side-Load Held to Blame for Damage—A Report on the Failure of Telephone and Telegraph Poles Under Heavy Ice Burden—Suggestions Given

By G. E. HECK*

Pictures taken immediately after the historical sleet storm which swept northern half of Wisconsin. These photos were taken to show the "sag" in the wires, some of them reaching almost to the ground between poles.

Contrary to a rather general opinion, the poles in telephone and telegraph lines will not fail by direct crushing even under such extremely heavy loads as were encountered in the ice storm of last February in the vicinity of Oshkosh, Wis. In fact, the dead load on the poles during this storm was only a small part of the load they were capable of supporting when not subjected to other stresses.

Observations made by the writer on 248 telephone and telegraph poles which failed from heavy ice loads on the wires during the above-mentioned storm, are the basis for the foregoing statement and the discussion and conclusions which follow.

The telephone poles examined carried four 10-foot cross arms, each with ten wires (presumably No. 12 hard-drawn copper). The cross arms were spaced 2 feet apart beginning one foot from the top of the pole. The poles were mostly of northern white and western red cedar, and spaced 130 feet apart. None of the poles had been treated, except a few replacements which had been givn a butt treatment.

The telegraph poles examined carried three 10-foot cross arms and were spaced 160 feet apart. The cross arms carried eight insulators per arm, indicating 24 wires in the line, and were spaced 2 feet apart, commencing one foot from the top of the pole. The poles were mostly northern white cedar, and apparently none of them had been given preservative treatment.

Cause of Failure in Poles

Since there was no wind during the ice storm, failure could not be attributed to this cause and must therefore have been due in some way to the heavy ice load on the wires. The ice coating on the wires varied in diameter from 2 to 4 inches and, together with the icicles hanging from the wires, in many instances resulted in a loading of 7 pounds per foot of wire, according to reports by officials of the Wisconsin Telephone Company.

The accompanying illustration shows quite forcibly the tremendous ice load on the wires and the resulting collapse of the poles in many cases. A load of 7 pounds per foot, however, is considerably greater than the unsupported wires (No. 12 hard-drawn copper) in a 130-foot span, will carry. Calculations show that an ice load of 1.4 pounds per foot and a sag of 10 feet would result in an elongation of 1.6 feet or 1.2 per cent, which is slightly greater than the total elongation such wires will stand without failure.

This load would correspond to a stress of 340 pounds at the cross arms, which is the ultimate breaking load for wires of this size and quality. A sag of 10 feet from approximately a horizontal position would, therefore, be about the maximum that would be possible without failure unless the poles deflect or something else occurs to permit a greater sag.

It is interesting to note that if for any reason the wires are permitted to sag without excessive elongation to 15 feet, then the ice load required to break a wire would be 2.2 pounds per foot. With a sag of 25 feet under similar conditions a wire would break at an ice load of 3.3 pounds per foot.

A loading of 1.4 pounds per foot and a sag of 10 feet, for a 40-wire lead with poles spaced 130 feet, would give

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a total load per pole of 7,280 pounds. The extreme loading of 7 pounds per foot of wire would result in a load of 36,400 pounds per pole. In either case, the load is well within the safe carrying capacity of an average pole, provided all wires hold.

Poles of the species and size examined would be expected to carry as much as 120,000 pounds end load before failure by crushing, provided no side load is acting. Tests show that the side load necessary to cause failure is only about 1/50 of this amount, or 2,400 pounds.

Any considerable number of wires would not be expected to break simultaneously in two adjacent spans. Rather would we expect failure of one or two wires in a single span, which would relieve a portion of the side load on one side of the pole and cause the top of the pole to deflect in the direction of the most heavily loaded span. This deflection of the pole would increase the tension in the remaining wires in the other span, cause more wires to break, and consequently add to the deflection of the pole.

This action would also result in considerable side load on the pole in addition to the end load. If the wires on one side of a pole in a 40-wire line break, the wires on the other side are capable of exerting a pull approximately six times the side load which a pole is able to resist.

Points of Failure in Poles

The inevitable result of the excessive stress caused by the combined side and end load is, of course complete failure of the pole by bending. One pole having failed, similar stresses are transmitted to adjoining poles in rapid succession, resulting in complete collapse of the line unless some form of bracing serves to check it.

Aside from the straight side pull to which a pole is subjected when all the wires on one side break, there may be a twisting stress caused by the breaking of the wires at one end of a cross arm. This stress may be severe enough at times to have considerable influence on the bending strength of the poles as well as the position of failure.

Out of 31 poles failing above the ground line, upon which it was possible to obtain complete data as to length and diameter, 11, or 36 per cent failed within 3 feet of the calculated point of maximum stress due to compression and side load, as determined for each pole by a formula which was derived for calculating the point of maximum stress or failure due to combined end and side load. Of these 11 poles, five failed above the calculated point of maximum stress, and six below this point.

Considering again the 31 poles failing above ground, 19 failed above and 12 below the calculated point of maximum stress. The average height of failure in these poles was at about one-third their height above the ground. The average calculated height of failure, or point of maximum stress was at one-fourth their height above the ground.

For an assumed pole length of 24 feet from ground to center of action of wires, failure then occurred on an average, 2 feet above the calculated position of failure. The average taper for the 31 poles which failed above the ground line was about one inch in 60 inches.

Torsional stress, together with the influence of the greater number of defects occurring higher in the pole, would easily account for the discrepancies between the average calculated point of maximum stress and the average actual point of failure, since the stress for a considerable distance above or below the point of maximum stress would vary but little.

Since the torsional stress is inversely proportional to the cross sectional area it is natural to expect failure to occur at the minimum cross section. This tendency in poles subjected to a twisting force would then bring the failure slightly higher in the pole than might otherwise be the case. Defects, as a rule, are more abundant higher in a pole. This fact, as previously indicated, would also have a tendency to raise the point of failure.

From the foregoing, it would appear that the formula gives results which agree very closely with actual data on the position of failure.

Ground-Line and Maximum Stress

It appears that there is little difference whether the strength of a pole is based on ground-line stress or on maximum stress. A pole is usually freer from defects and inherently stronger near the ground than higher up, but the presence of more moisture and decay at the base tends to off-set this advantage over material higher in the pole.

If the taper is such that a diameter of one and one-half times that at the center of action of the side load is found above the ground line, then the maximum stress due to side load only is at this point of 1.5 diameters. When the taper is less this maximum stress is at the ground line.

The average diameters at center of action of side load and at failure for 34 telephone poles, including 9 which failed at the ground, were 8.4 and 12.1 inches, respectively. This gives a ratio between diameter at failure and diameter at center of action of side load, of 1.44, which compares very closely with the theoretical ratio of 1.5 for side load only.

This ratio for 21 telegraph poles, including 13 of which failed at the ground, was 1.3, the average diameters at point of application of load and point of maximum stress being 8.8 and 11.6 inches, respectively. Excluding the 13 poles failing at the ground, this ratio becomes 1.26 for the 8 telegraph poles failing above ground.

Methods of Reinforcing

The practice of setting double poles at intervals will, undoubtedly, prove of some value in resisting failure from wind loads, trees and limbs falling on wires, failure of a few wires, and similar causes. From the foregoing discussion, however, it is evident that some means other than double poles at intervals would be necessary to stop poles from breaking under heavy ice loads when the wires in one span give way.

A better means of reinforcing the lines would be to run guy wires from the tops of occasional poles to the bases of adjacent poles on either side in the line. Another method which might prove more effective would be to guy occasional poles in four directions.

Analysis of the data lead to the following conclusions:

1.—Telephone poles subjected to bending only are quite likely to fail at the ground line, because of decay and increased moisture content. Poles subjected to heavy ice loads are likely to fail considerably above ground, but at loads only slightly less than those which would cause failure at the ground line. The force required to break any of the poles under discussion was only a small part of the force which the wires in a single span were capable of exerting when the wires in an adjacent span had broken.

2.—Extra large poles, or even sev-

STUDIES STORM STUFF

By the exceptional things we often learn many facts which help us in ordinary things. G. E. Heck, a forest service engineer, went out into the great sleet storm of 1922 in upper central Wisconsin and made some observations.

What he learned in that storm may have wide influence in line construction throughout all of the North Country. Wherever there is chance that a great sleet storm will play havoc with a system the telephone company official will want to know how to prepare against it.

We think this article tells.

THE EDITOR.

Left, a pole broken by stress caused by shifting of the load. Right, the double pole or H-type, which if placed at intervals will help to relieve side-stress and save parts of the line from collapse.

eral poles at intervals in a line will not prevent pole failures from heavy ice loads on a large number of wires.

3.—The observed average height of failure for the poles not affected by decay at the ground, or other serious defects, was about one-third the height of pole above ground, when subjected to a combined end and side load.

4.—The calculated height of failure, or point of maximum stress in these poles when subjected to combined end and side load, was about one-fourth the height of pole above ground. The poles actually failed, therefore, about one-twelfth their length higher than the formula would indicate.

5.—The ratio of diameter at failure to diameter at center of action of side load was only slightly less than 1.5, the theoretical point of maximum stress for poles of uniform taper and subjected to bending only.

6.—The compressive or dead load on the poles during the ice storm was only a small part of the load they were able to support when not subjected to bending.

7.—In calculating stresses in poles the dead load should be ignored and the stresses usually determined at the ground, although occasionally it may be desirable to determine the stress at a point where the diameter is one and one-half times the diameter at center of action of side load.

8.—The most effective means of preventing a whole line from collapsing under conditions of severe loading would be to run guy wires from the tops of occasional poles to the base of adjacent poles on either side, or to guy occasional poles in four directions.

"THEY NEVER STRIKE"

By Nellie Leatherman

"A funny bunch—they never strike"
  Thus ran the title bold,
But underneath the words there lay
  Full many a tale untold.

The lineman sings as he strings his wires
  By the side of the winding road,
And the very trucks creak with joy in their work,
  No matter how heavy the load.

The girls at the switchboards have voices of cheer
  Which echo all over the earth,
And although their work seems the hardest of all,
  They respond with a chuckle of mirth.

The offices hum with the merry sound
  Of work that is gladly done,
And there's plenty of smiles floating 'round in the air.
  But of frowns—there's never a one.

The telephone rings with a joyous note
  As if it were glad to be there,
And even the stern old adding machine
  Clicks with a satisfied air.

For all of them know that their work will count
  In helping the world along,
And that is the reason that on their lips,
  And in their hearts—there's a song.

Editor's Note—This poem was adapted by Miss Leatherman from Collier's article on telephone people: "They're a Funny Bunch—They Never Strike."

—From The Mouthpiece.

French Technical 'Phone Journal Becomes a Bi-Monthly

Paris, France.—Les Annales des Postes, Telegraphes et Telephones, the technical publication of the French postal administration, which has been published annually for many years, will be published as a bi-monthly from now on. Although there will be a considerable increase in the amount of material published, the price of the annual subscription remains fixed at 24 francs in France and 27 francs for foreign subscribers. The magazine is edited by the Librarie de l' Enseignement Technique, 3, rue Thenard, Paris.

Worst Ice Storm in Years Plays Havoc in Ohio

Cleveland, O.—The worst ice and sleet storm in many years did great damage to telephone lines in many parts of Ohio. The heaviest losses fell in the eastern parts of the state. Some of the centers where the most damage resulted are Upper Sandusky, Mt. Vernon, Bucyrus, Waynesfield, Uniopolis and St. Johns. At times the wind reached a velocity of 45 miles an hour.

Want Storm Damage, Done a Year Ago, Repaired

Mt. Pleasant, Mich.—Damage done by the terrific sleet storm a year ago to the lines of the Union Telephone Co. have been only partly restored. The Chamber of Commerce of Mt. Pleasant has asked for a hearing before the public utilities commission to compel the company to restore the lines.

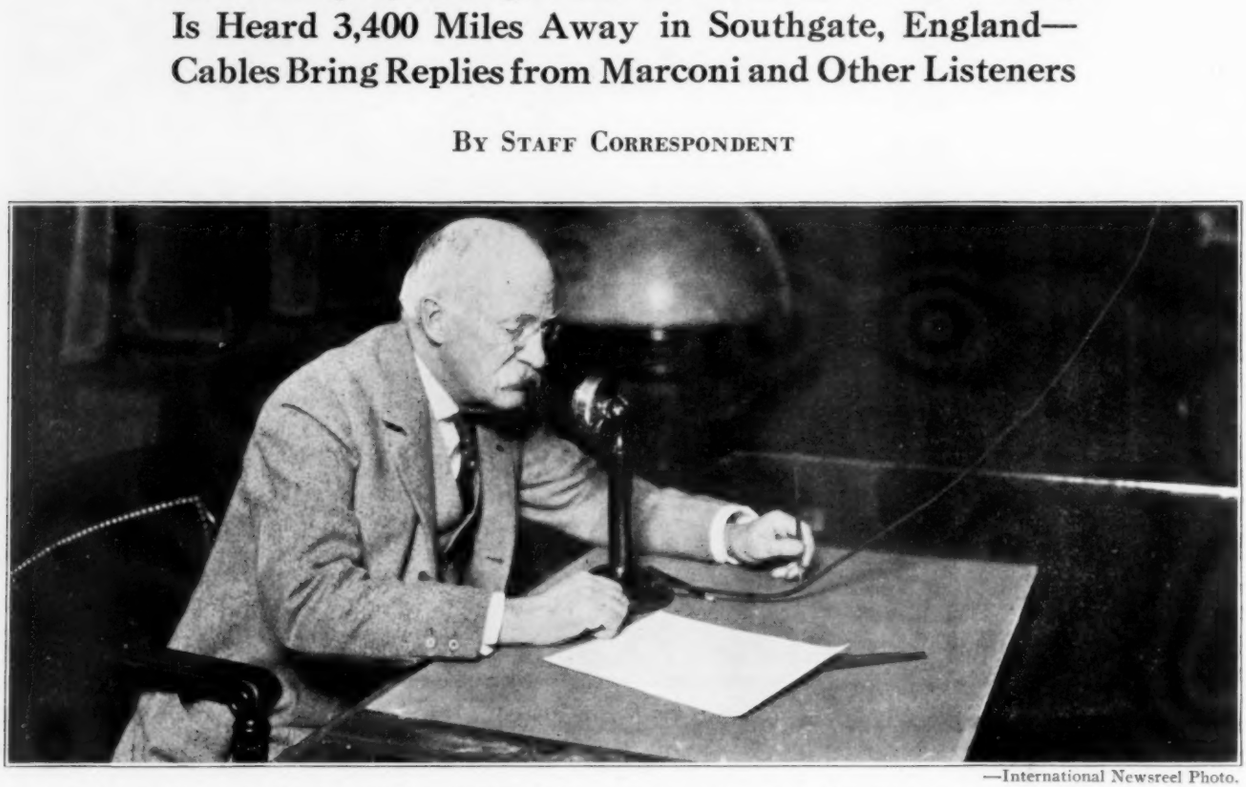
Illinois Bell Adds 54,000 Telephones in a Year

Chicago, Ill.—The Illinois Bell Telephone Co. reports that it added 54,000 telephones in Illinois in 1922. Of these about 32,000 were in Chicago alone. During the last year 22,000 shares of stock were sold to the public. The company spent $18,000,000 last year to increase its facilities in Illinois.

'Phone-Radio Spans Atlantic

H. B. Thayer, Sitting at His Office Desk in New York, Is Heard 3,400 Miles Away in Southgate, England—Cables Bring Replies from Marconi and Other Listeners

By Staff Correspondent



—International Newsreel Photo.

H. B. Thayer, president of the American Telephone & Telegraph Co., talking from his office in New York to England by radio telephone. This test was made possible by the co-operation of the Radio Corporation of America.

New York, N. Y.—America has talked to England by wireless and found England, for once, unable to "talk back." The interesting one-way conversation was started by H. B. Thayer, president of the American Telephone & Telegraph Co., on the night of Jan. 14 and was continued by J. J. Carty, vice president.

On the receiving end, in England, was Guglielmo Marconi, inventor of radio, who was listening in at Southgate, England, by special arrangement. Others who where listening at the English station are:

Captain Brandy of the British Air Ministry; Sir E. Murray, Major T. J. Purves, R. A. Dalzel, F. J. Brown, E. H. Shaughnessy and Mr. Lipton of the British Postoffice; Dr. W. H. Eccles and A. A. C. Swinton of the British Institution of Electrical Engineers, S. J. Goddard of the Western Union Telegraph Co., Captain Miles of the United States Embassy, Sir A. Shirley Bonn of the Associated Chambers of Commerce, G. Marconi and Godfrey Isaacs of Marconi's Wireless Telegraph, Ltd., representatives of British scientific publications, Chief European Engineer Frank Gill of International Western Electric Co.

Mr. Thayer, in opening his conversation across the Atlantic, said:

"This is Mr. Thayer of the American Telephone & Telegraph Co. speaking from 195 Broadway, New York City, through the Rocky Point station of the Radio Corporation of America.

"The radio apparatus and system used in this test is made possible by co-operation between the American Telephone & Telegraph Co. and the Radio Corporation of America and is the result of research and experimental work in the laboratories of the American Telephone & Telegraph Co. and in the laboratories of the Radio Corporation of America and its associated companies.

"In 1915 the American Telephone & Telegraph Co. transmitted a message across the Atlantic by radio telephone from Arlington, Va., to the Eiffel Tower in Paris, where it was heard and understood by our own engineers and by others. During 1915 we also sent a telephone message from Arlington part way across the Pacific ocean to the Hawaiian Islands, where it was heard and understood by our own engineers and by officers of the United States Navy.

"Since then great improvements have been made in the art not only of radio but of telephony and of radio telephony. In experiments which we are now conducting we are making use of these improvements."

The speaking was done from the company's offices at 195 Broadway. An ordinary telephone instrument was connected to the radio equipment at Rocky Point by a telephone circuit about 70 miles long, half of it being underground cable and half open wire, and containing telephone repeaters and equalizers of a type similar to those used on long distance telephone lines.

The distance from Rocky Point to New Southgate, England, is about 3,400 miles. A short time after the experiment was started Marconi sent the following cable, addressed to President Thayer, which was received by him shortly after 10 o'clock:

"I have just listened to your radio telephonic message which I have heard distinctly and congratulate you and all those connected with the research which has led to this achievement."

Major T. J. Purves, chief engineer of the British postoffice, also cabled, saying:

"I have listened with great interest and pleasure to the far-flung voices of Mr. Thayer and Mr. Carty. Of Mr. Thayer's message, I recognized every word. I missed a little of Mr. Carty, but recognized his well-known intonations. Send best respects and warmest good wishes to our friends of the A. T. & T. Co."

Other cablegrams also came in during the program. Some of them said that trouble was being experienced in understanding the "American accent" and a request was made for a "bit of English." Maybe it was a bit of British humor. The Americans, seeking to give 'em what they wanted, started out to rustle up the English janitor but he couldn't be found.

He was off the job, however, for it was past working hours. Suggestion was made that perhaps he had dropped out to find a mug of brew at some New York pub or ale house. And so they went without.

Fight in Louisiana Settled with Cut in Rates

New Orleans, La.—The Cumberland Telephone & Telegraph Co. has agreed to accept the order of the Louisiana public service commission which cuts the price of residence telephones from $5 to $4.50; party lines from $4 to $3.50 and business phones from $10 to $9 a month in New Orleans. Cities throughout the state are affected proportionately. As the cut is retroactive the company will be compelled to refund $440,000 listed as overcharge to subscribers.

Minnesota Has An Epidemic of Legislative Regulation

Minneapolis, Minn.—The Minnesota legislature is in the throes of an epidemic of leigslative regulation. Efforts are being made to make life hard for all the public utilities. Allen J. Furlow, senator from Rochester, is fathering a couple of bills aimed at the telephone industry.

$500,000 for Phone Extensions, San Antonio Plan

San Antonio, Tex.—The Southwestern Bell Telephone Co. plans to spend $500,000 in San Antonio for extensions and increased telephone facilities in 1923. The company spent $500,000 in 1922 and added in the year 2,546 telephones.

Lawrence, Kas.—Phone subscribers in Lawrence will be granted a 10 per cent cut on their bill if paid before the 10th of the month. The Kansas Telephone Co. operates here.

CONFER ON RADIO

Standardization Plans Mapped Out at Meeting of 'Phone Men, U. S. Chiefs and Others

New York, N. Y.—A conference called by the Bureau of Standards on Jan. 12 to consider the matter of radio standardization went on record as favoring such action and voted to ask the American Institute of Electrical Engineers and the Institute of Radio Engineers to act as joint sponsors for a special committee to be formed under the American Engineering Standards Committee.

The conference drew a large attendance from among the organizations interested in the radio field and included representatives of the radio manufacturers', radio jobbers and retail dealers' associations, Departments of the federal government and power and light and telephone companies. Dr. F. C. Brown, acting director of the Bureau of Standards, was the presiding officer.

The program consisted of a number of short papers and a general discussion of various topics related to the proposed standardization. Dr. Brown made the opening statement calling attention to the possibilities of standardization and the reasons for calling the meeting. He was followed by Dr. J. H. Dellinger, chief of the radio laboratory of the Bureau of Standards.

Data on Results Needed

Dr. Dellinger pointed out the dissatisfaction of the consumer of radio apparatus with present methods of rating and the impossibility of obtaining accurate information as to the performance. The attention of the bureau was called to the matter by the National Retail Dry Goods Association and by the Electrical Testing Laboratories and after consultation with a number of interested associations the call for the conference was sent out.

Dr. A. N. Goldsmith, discussing the subject from the standpoint of the radio engineer, pointed out the advantage of a reasonable amount of standardization but sounded the warning that any standardization must not be so rigid as to prevent the development of new and improved apparatus and methods of operation. He outlined the past work of the Institute of Radio Engineers of which he is the Secretary, in standardizing radio nomenclature. W. H. Davis, of the National Radio Chamber of Commerce, dwelt on the necessity of gaining the respect and confidence of the public if radio is to succeed. Standardization, he said, must dispose of waste, conflict and loss in matters in which no individuality is necessary.

J. V. L. Hogan, consulting radio engineer, discussed some of the apparatus in which standardization was necessary and Dr. P. G. Agnew outlined the procedure of the American Engineering Standards Committee in adopting recommended standards.

Admiral H. J. Ziegemeier and Commander Hooper, of the navy, and Major Bender, of the army, gave the viewpoint of the government military and naval authorities and showed to what extent standardization had already been carried in their respective branches of the service. W. A. Wheeler pointed out the importance of radio to the farmer and the part that definite and dependable ratings would play in inducing the farmer to buy radio equipment.

A number of other representatives also spoke giving their ideas of standardization and finally a resolution was adopted expressing the opinion that standardization should be begun.

After further discussion it was decided to ask the Institute of Radio Engineers and the American Institute of Engineers to act as sponsor societies to form a special committee under the American Engineering Standard Committee to proceed with the work. All matters relative to the lines of work on which standardization should be undertaken and the extent to which standardization of apparatus and services should be attempted were referred to the special committee which is to be formed.

The United States Independent Telephone Association was represented by F. Holmstrom, Jr., New York manager of the Automatic Electric Co., and by R. V. Achatz. A. H. Griswold was the representative of the American Telephone & Telegraph Co. and the Associated Bell companies.

Memphis Company Is Granted Raise for Construction

Memphis, Tenn.—Because no less than 6,000 persons in Memphis are clamoring for 'phones which they cannot get because the telephone company hasn't the money, a rate increase has been granted by the state utilities commission. This is held to be equivalent to an additional $300,000 in a year. It is estimated that the company's expenditures will be $2,000,000 in 1923.

New York, N. Y.—The New York Telephone Co. has let a contract to Emil Diebtsch for a $500,000 exchange at Albermarle road near Flatbush ave.

100 MEET IN HURON

South Dakota Telephone Association Holds Its Seventh Annual Convention

Huron, S. D.—The South Dakota Telephone Association held its seventh annual convention on Jan. 17 to 19 at the Marvin-Hughitt hotel in Huron. The attendance was a little more than 100, mostly members. A few telephone men from nearby states were present to take part in the program.

Officers elected for the coming year are as follows: L. H. Snyder, White Lake, president; J. J. Bollinger, Bridgewater, vice president; Thomas J. Phalen, Aberdeen, secretary and treasurer. The board of directors for the year is composed of J. A. Steninger, of Parker, retiring president; M. E. Guinter, of Sioux Falls; A. L. Curtis, Castlewood, and F. L. Wheeler, of Scotland.

Mr. Steninger, in his annual address, told those present that a vast amount of good can come from meetings and conferences and proposed that the state be divided into districts so that more local meetings, at which local problems can be discussed, will be held. He also spoke of the value of standardization of equipment and said that this work should be taken up seriously.

Charles C. Deering, of Des Moines, Ia., secretary and treasurer of the United States Independent Telephone Association, was present and spoke on the work that the national association can do to assist the smaller companies in ironing out their difficulties. The central association, he said, is in close contact at all times with the Interstate Commerce Commission and the Internal Revenue Department and is anxious to help in every way possible when national problems bob up.

V. C. Kennedy, of Sioux Falls, discussed the difficulties that arise when power and communication wires are strung on the same poles and told how to overcome them. W. G. Bickelhaupt, of Aberdeen, discussed legislation, past and proposed, and advised in methods of procedure to avoid trouble-making laws.

J. J. Murphy, of the South Dakota railroad commission, gave a talk on the contact between the commission and the telephone industry. George T. Gorham, of Omaha, Neb., discussed maintenance of the central office and equipment.

R. Y. Hyde, also of Omaha, spoke on construction work at the outside plant. G. E. Beatty, of Sioux Falls, discussed the maintenance of the outside plant.

The reports of the various committees, acting during the year were presented. A. S. Kelly, of Omaha, Neb., made the report for the legislative committee; Thomas Phalen for the traffic committee; and M. E. Guinter, of Sioux Falls, district commercial manager of the Northwestern Bell, for the public relations committee.

President Snyder appointed committees for the year as follows:

Legislative: W. G. Bickelhaupt; A. S. Kelly and J. K. Seckler, of Faulkton.

Traffic: J. J. Gibbs, Sioux Falls; T. J. Phalen and A. N. Van Camp.

Public Relations: M. E. Guinter; F. L. Wheeler, Scotland, and T. J. Phalen.

Taxation: C. E. Hall; W. G. Bickelhaupt and L. H. Snyder.

Auditing: J. J. Bollinger; F. L. Wheeler and T. H. McCullough, of Avon.

Resolutions: C. E. Hall; A. N. Van Camp and Ira S. Burdette, of Armour.

Mr. Steninger, the retiring president, acted as toastmaster at the annual banquet. Short talks were made by W. G. Bickelhaupt, T. H. Null, Charles C. Deering, H. P. Hartwell and others.

Texas Legislators Plan Bills to Worry Utilities

Austin, Tex.—With the Texas legislature in full swing again the usual batch of bills aimed at the public utilities is being mixed up. A bill fathered by Representative Gipson would put telegraph and telephone lines under the railroad commission. Another fostered by Senator Murphy, establishes a minimum wage for women. This minimum is said to be so high that it very likely would force many small telephone companies out of business.

Texas Independent Association to Dallas March 20-23

Dallas, Tex.—The Texas Independent Telephone association will hold its annual convention at the Adolphus Hotel, Dallas, March 20, 21, 22 and 23. R. B. Still, of Tyler, is president and L. S. Gardner, of Waco, secretary. President Still presses all independent telephone managers and owners in Texas to attend and pledges profitable days for manufacturers and dealers.

Couderay, Wis.—The Couderay Telephone Co., capital $25,000, has been organized here. H. F. Mann is president.

HIT PATENT CHARGES

Witnesses in Chicago Hearing Object to Capitalization of Licenses

Chicago, Ill.—In the hearing before the Illinois commerce commission, recently resumed here, the city of Chicago, which is seeking a reduction in telephone charges, has made an attack on the custom of basing rates on patent charges. It is contended that original patents, having expired, patent costs should be eliminated.

William H. Crumb, an engineer employed by the city, testified to the decrease in per station costs, over a period of years up to 1911 and its following increase. He explained the increase in costs in recent years as a "decrease in efficiency" on the part of traffic employes.

This, he said, was largely due to failure to keep equipment up to the standards required by the large increase of business. Mr. Crumb testified that it was his belief that had the telephone company been able to operate in 1921 with the same efficiency as in 1915, it could have handled 70.3 calls per traffic employe hour instead of 56.8 calls, the reduction in the average number of calls per station per day amounting to 18 per cent in the volume of traffic would have permitted an 18 per cent reduction in traffic expense.

He added that many of the independent telephone companies in this same time had increased their efficiency instead of letting it drop to lower levels. Henry Shafer, another witness for the city, discussed the patent situation.

He contended that the Chicago Telephone Co. had been influenced by the American Bell Telephone Co., which controlled it, to sign new rental agreements in years gone by after the patents had been declared invalid by the courts. It is the contention of the city that the patent charges should vanish.

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100 Years to Grow a Pole; Chemicals Prolong Life

New York, N. Y.—Research investigations indicate that it takes more than 100 years to grow a telephone pole. The most of them are cedar, yellow pine or chestnut. Owing to the chestnut bright these poles are fast becoming a thing of the past along the upper Atlantic coast. Experiments are being made with coal tar creosote and other preservatives to lengthen the life of poles.

Plans European Long Lines

Frank Gill, Made President of Institution of Electrical Engineers, of Great Britain—Offers Solution of Through Telephone Service for Many Nations

Frank Gill, European chief engineer of the International Western Electric Co., was recently elected president of the Institution of Electrical Engineers, the largest and most important Electrical Engineering Society of Great Britain.

In his inaugural address he outlined a concrete plan for the improvement of the European telephone system to include a long lines telephone system which would connect practically the whole of Europe in one great long distance telephone system, furnishing a more adequate service than is possible with the many telephone systems now operating.

Mr. Gill compared the telephone system of the United States, by which a subscriber can communicate with any one of 13,700,000 other subscribers in practically any village, town or city, with the many telephone systems of Europe, each owned and operated by its own government and responsible to nobody for the efficient handling of calls originating in other countries, and to be received in still other countries. This is the reason the "through business" is meager in quantity, slow and inefficient.

Not an Engineering Hazard

It is not caused, however, by any engineering difficulty as far as distance is concerned in constructing and operating lines at commercial rates to give satisfactory speech from any part to any other part of Europe. But under the present conditions, about the only way in which the nations can co-operate in these matters when lines are being constructed between countries is for the representatives of the countries concerned to hold consultations. Occasionally, an international conference is held, but these cannot produce a unified system.

Mr. Gill said that given the facilities, there is traffic waiting to be handled between the cities of Europe as between the cities of the United States. The opinion of those well qualified to judge is that the differences in languages and customs do not constitute a serious bar to international communication by telephony. But there is little likelihood of speedy economical construction and operation

Frank Gill

of such lines as are necessary between say London and Stockholm with three or perhaps five intermediate non-interested countries between.

The direct distance overland between London and Delhi, India, is about the same as the direct distance from Key West, Florida, to New York, thence to San Francisco, and thence to Los Angeles over which distance calls can be made regularly. The New York-Chicago cable, now in the course of construction, will have a transmission equivalent, equal to that of a No. 8 B. W. G. open wire circuit, ten thousand miles long.

This would be enough to connect Paris to the telephone system at Seattle, and leave enough to spare to take care of the cable across the Behring Strait. Of course, this illustration is un-commercial, but it serves to indicate that distance is now no barrier to telephony provided lines can be constructed and telephone repeaters used to amplify the speech currents.

In the United States there exists a telephone service such as is not known in Europe, and yet, due to the fact of its denser population and less distant cities, there is no reason why the service in Europe should not be extended in some similar manner. But the "through business" must be handled by a complete unit if it is to be efficiently done. And under present conditions each nation in Europe is, from a telephone point of view, merely conducting a local business over an area which is not very great.

Each local authority, although vitally interested, must at its boundaries hand over the conducting of its business in part to someone else. The correct course, therefore, appears to be to depute a commission to do for all the European nations that which no nation can do for itself. If it were possible for nations to agree on unity of control for the purpose of war, it ought not to be beyond the powers to agree to a unity of control for the efficient working of the through telephone business.

Problems to Be Overcome

It is not enough for the separate organizations to attempt to agree to a code of rules to which each shall subscribe. Control can only be effected by a living authority always on duty. Besides the engineering considerations, there are weighty reasons connected with the circuit layout, business policy, rates and operation, which make it impossible to give an adequate through service without unity of control.

In his conclusion, Mr. Gill offers the following concrete and alternative plans for the establishment of adequate through service.

"First, operate all the through business, both within and between the various countries in Europe, by a single Long Lines Company, working under licenses from the various governments, taking the calls from the local originating organization and being entirely responsible for them until turned over to the local receiving organization.

"The second alternative is for the various governments to form what would in effect be a private company or commission, of which the governments would be the stockholders, and from each subscribing government the commission would derive its authority in that country. The commission being supplied by funds on some agreed plan of participation by each govern-

ment, would be the sole judge of the plant to be constructed and operated within the scope of the money put at its disposal and it would assume the ordinary responsibilities of a board of directors of a public company carrying out all the necessary functions and periodically reporting results to those who supplied the capital."

"The third is frankly one of a temporizing nature. It is that the various operating telephone authorities should form themselves into an association for the purpose of studying this and other matters."

"If I may venture to make a definite suggestion, it is that the telephone authorities of Europe—including the United Kingdom—as telephone-operating authorities rather than as government departments—should hold an early conference of all the telephone authorities, companies and municipalities, as well as government departments, to study in detail this problem and endeavor to find its solution."

France Suffers with 150 Types of 'Phone Instruments

New York, N. Y.—France is probably cursed with more varieties of telephone instruments than any country under the sun. It is estimated that fully 150 varieties are manufactured and sold in that country. The reason is that the subscriber is required to buy the instrument outright which he gets on the public market. The government, which operates the lines, undertakes the maintenance and the vast variety causes much expense and inconvenience. And that's another argument against government ownership and control.

Wedding Bells Ring for P. Kerr Higgins, Engineer

St. Louis, Mo.—P. Kerr Higgins, the well known telephone engineer and author, of St. Louis, was married on Jan. 30 to Miss Gertrude Edith Phillips. Miss Phillips is a sister of Richard W. Phillips. The wedding was at Newport, Ky.

L. M. Holliday Promoted to General Commercial Agent

Omaha, Neb.—L. M. Holliday, assistant to the president of the Northwestern Bell company has been promoted to general commercial agent of the Omaha exchange.

Lyons, Neb.—Matthew Pond, local manager of the Bell company at Lyons has been promoted to area manager at Fremont, Neb.

G. E. Cullinan

Western Electric Co. Announces a Series of Promotions

The Western Electric Co. has announced promotions as follows: F. A. Ketcham, general sales manager to general manager; G. E. Cullinan, central district manager, Chicago, to general sales manager; L. M. Dunn, eastern district manager, to general sales manager, general manager's staff; W. J. Drury, sales manager, New York, to manager of the eastern district; J. F. Davis, sales manager, Boston, to succeed Mr. Drury; T. E. Burger, to sales manager, Boston; W. P. Hoagland, sales manager, Chicago, to central district manager in charge of Chicago and Minneapolis branch houses; J. H. Gleason, power apparatus sales manager, Chicago, to Chicago sales manager; H. L. Grant, general appliance manager, New York, to Erie district manager, a new grouping of the distributing houses at Cleveland, Pittsburgh, Detroit and Cincinnati. All of the above changes are in the nature of promotions.

H. C. Johnson Succeeds James Hardacre at Lawrenceville

Lawrenceville, Ill.—H. C. Johnson has been appointed manager of the Citizens Telephone Co., of Lawrenceville. He succeeds James Hardacre, resigned. Mr. Johnson was formerly county clerk and postmaster here and is manager of the local ice and cold storage plant.

Paul M. Lincoln Succeeds Prof. Gray at Cornell

Ithaca, N. Y.—Paul M. Lincoln has been made director of the school of electrical engineering at Cornell University. He succeeds the late Prof. Alexander Gray. Mr. Lincoln has had wide experience in the electrical field with which he has been identified for thirty years. He has had experience with the Short Electric Co., of Cleveland; the Westinghouse organization, at Pittsburgh; the Niagara Falls Power Co. of Niagara Falls, and the Lincoln Electric Co., of which his brother was the founder. He has been active in the affairs of the American Institute of Electrical Engineers and was at one time its president.

Walter F. Brown, of Denver, Dies of Pneumonia

Denver, Colo.—Walter F. Brown, general traffic manager of the Mountain States Telephone & Telegraph Co., died here on Jan. 17 of pneumonia. Mr. Brown was suffering from a severe cold when he acted as toastmaster at the banquet of the Telephone Pioneers of America on Jan. 8 and immediately after became ill. He was born in 1873 at New London, Conn., and was a graduate of Yale. He has been prominent in telephone circles for many years.

Buyer of Clarendon Company an Old Head in Business

Clarendon, Tex.—O. L. Fink, who recently purchased the Clarendon Telephone Co., is a veteran in the 'phone field. He was manager of the Wills Point company for ten years and for some time was associated with a brother in the management of the Mexia exchange. For the last five years he has been active in the telephone business at Wellington, Tex.

J. C. Hay Succeeds T. B. Baird at New Orleans

New Orleans, La.—J. C. Hay has been appointed district manager of the Cumberland Telephone & Telegraph Co., at New Orleans. He succeeds T. B. Baird who is transferred to Birmingham, Ala. Mr. Hay has lived in New Orleans nine years and is prominent in civic work. He is also a director of the Rotary club.

Fred C. Gardner a Director in the Indiana Bell

Indianapolis, Ind.—Fred C. Gardner, well known hotel man and treasurer of E. C. Atkins & Co., has been elected a director of the Indiana Bell Telephone Co.

Standardizing 'Phone Rates

Apparent Faults Found in the "Cost Plus" System—Monopoly and the Element of Competition, Factors in Development—System of Bonuses and Penalties Plan

By C. A. Wright and D. B. Judd

Nearly every state in the United States has a public utility or railroad commission, with authority to regulate rates and to otherwise protect the telephone-using pubilc and the telephone companies. In the majority of cases these commissions have also the authority to prescribe uniform systems of accounts, to authorize the issue of securities and dividends, to fix and enforce standards of service, and to generally supervise the relations of the public utilities with the public.

While it is not claimed that regulation of the telephone companies by these public utility commissions has been a failure, or even unsuccessful, it has appeared to many of those interested that it has not accomplished its full purpose.

Apparent faults of the present "cost plus" system of determining telephone rates are:

1—No incentive is offered the telephone companies to better their service or provide it economically.

2—The system of regulation is laborious and expensive. It is burdensome to the public utility commissions and more so to the telephone companies.

3—The present system of rate determination is not exact and definite, but involves much guesswork.

4—The present system of regulation does not, in every case, prevent injustice to telephone companies or telephone subscribers.

Objects of Investigation

The object of the investigation which has been made and which is described in this report was to attempt to obtain information and suggest methods which may be helpful in correcting some of the deficiencies which have been most subject to criticism. By introducing an element of competition into the operation of the telephone companies, the system of rate determination which is suggested offers a remedy for (1) and a partial remedy for (2) without emphasizing (3) and (4).

This report sets forth also some methods of investigation which may be found useful by others interested in this problem.

It does not attempt to decide what elements constitute a fair valuation, what methods should be followed in dealing with depreciation and depreciation funds, or rate of return, whether or not a utility should be taxed or subsidized, or the many other legal and economic problems of rate regulation.

It does not attempt to discuss the organization or personnel of the public utility commissions or primarily to decide whether original or reproduction or normal costs should be recognized as the fair basis for rate determination, but the methods suggested do base rates upon normal telephone plant costs; that is, average plant costs over a number of years, rather than the cost of any particular telephone plant.

This report suggests a system of rate determination in which the rates for any community are the average rates for communities of the size of the community in question, modified by bonuses or penalties which take account of the natural obstacles presented to the telephone company and the quality of the telephone service made available to the community.

Assumptions, Plans, Predicted Results

The following assumptions have been made:

1—That the purpose of the regulation of the financial policy and service of telephone companies is to obtain the best possible telephone service at the lowest cost which is just to the telephone companies. In order to accomplish this the state grants the telephone company a monopoly in its community and enforces rules which limit the return on the investment and prevent speculation.

Because there is no chance to obtain an extraordinary return on investment, however, the incentive for providing good service economically is small. The "cost plus" system of rate regulation in its present form is not conducive to efficient management.

2—That if the investment in the telephone company is completely safeguarded from the effects of competition in a given operating field and speculation, a small guaranteed return on the investment will attract sufficient new capital to the utility to provide necessary extensions of the service. Under a competitive system the return over the cost of giving the service would be interest plus a profit which is reasonable for the risk involved.

If risk is eliminated by permitting only one company to operate in a given operating field rates which consist of cost of giving the service plus interest will not only be just but sufficient to attract new capital to the enterprise. If a telephone company is allowed to become such a monopoly, the element of competition must be introduced in some other manner if there is to be any incentive to good management.

Should Be Self-Sustaining

3—That the telephone service in each community should be self-sustaining. This does not necessarily mean that each class of local service in a community should be self-sustaining, but it does mean that neither local nor toll service should be supported in part by the other. Exception to the assumption that the telephone service in each community should be self-sustaining might be taken in one possible case, that of very small communities.

4—That not only should the relative values of telephone service to the subscribers in the various communities be considered in fixing rates, in addition to the cost of producing the service, but that they actually have been considered. Telephone companies will contend more strenuously for reasonable rates if the service is good, and under these conditions, the public utility commissions will more readily grant them, and the public will more willingly pay them.

However, the various indications of the value of the service have not always been considered in their proper relative importance. "Free service" between communities, and the general impression of the public utility commissions of plant conditions have been given too much consideration.

Among the factors which affect the cost of producing the service are the number of stations served, the calling rate, and the extent of the territory served. Among those factors which affect the value of the service to the

subscribers are the number of stations served, and the quality of the service. The use made of the telephone by the average subscriber, and the telephone development are taken as measures of the quality of the telephone service. These indications of the cost and value of service have not been given sufficient consideration.

5—That the wage scale will vary only with the size of the community, and that the cost of all telephone plants serving the same number of stations should be the same, except for the differences due to extent of territory served and the maximum calling rate.

This plan for the standardization of telephone rates suggests:

1—That if the rates of a sufficiently large number of telephone exchanges serving the same number of stations are averaged, the average rate is the fair one for exchanges of that size. It is the rate which will produce income sufficient only to cover the cost of the service, and provide a reasonable return on the investment.

Typical Average Rates

The effects of excessive competition, monopoly, and unfair influence which are of advantage to the telephone company in some cases, and in other cases to the community, will be eliminated if a large number of cases are considered. Typical average rates have been obtained and are presented in this report.

2—That when any particular telephone exchange is considered the natural obstacles which the telephone company has to overcome, and the degree of excellence of its service should be recognized by bonuses or penalties applied to the average rates for exchanges of the size of the exchange in question.

There have been taken as the bases for bonuses and penalties (a) the length of pole line per station, which is an approximate measure of the extent of the territory served by a telephone exchange, (b) the maximum busy hour calling rate per station, which is an approximate measure of the proper size of the central office, (c) the average number of calls per station per day, which is an approximate measure of the cost of operation and of the value of the telephone service to the individual subscribers, and (d) the development in telephones per thousand people in the area served, which is also an approximate measure of the value of the telephone service to the subscribers.

Bonuses and penalties "b" and "c" are combined in one in this investigation. The desirability of recognizing plant condition by a bonus or penalty should receive consideration.

Consciously or unconsciously the public utility commissions, the telephone companies and the telephone-using public have recognized the above bases for bonuses and penalties, but not to a sufficient extent. In this report is presented a method of determining the degree to which they have been recognized, and analyses have been made of average but typical companies which show the extent to which they should have been recognized. Other bases for bonuses and penalties are discussed in another section of this report.

By this plan the telephone companies are allowed the advantages of monopoly in their respective operating fields, and the element of competition, with its attendant advantages is introduced by the system of bonuses and penalties. Each company competes with others in its class for bonuses. For all bonuses that are granted, penalties must be assessed also, as the bonuses and penalties are based upon the average rates for the class of telephone companies which includes the company in question.

Many advantages of the proposed plan may be predicted. It may be stated generally:

1—That if the public utility commissions fix average rates corresponding to the numbers of stations served, modified by the bonuses and penalties suggested, their work will be decreased to such an extent that reasonable attention may be given to fixing standards of service and enforcing them.

2—That the suggested bonuses and penalties will offer an incentive to the telephone companies to better their service, independent of the efforts of the public utility commissions.

3—That the possession by the public utility commissions, the telephone companies, and the telephone-using public of a knowledge of what are the average and therefore just rates, and the just bonuses and penalties will tend to promote harmony in fixing rates.

The above assumptions, suggested plan, and predicted results will be discussed more fully in other sections of this report.

(In another article to be printed soon Prof. Wright will discuss "The Present Method of Determining Telephone Rates" with comment. Afterward will follow an article on "A Proposed Plan for Determining Telephone Rates.")

SHORTS

Radio fans have been warned by the Pacific Telephone & Telegraph Co. to keep their antennae off of telephone poles. Those who use the poles for anchorage are told that the radio interferes with the telephone system and also endangers linemen in their work.

* * *

The Italian government is reported to have had its fill of public utilities management and is planning to turn back the utilities, including the telephone and telegraph lines.

* * *

Statisticians have figured out that Americans average to spend sixteen hours each per year in telephone conversations. This makes us the greatest 'phone conversationalists in the world. Probably some women talk more than their share.

* * *

Conversation is estimated in some other countries as follows: Denmark, Sweden and Norway, twelve hours; Germany, five hours; Switzerland, three hours; Great Britain, two hours; France, one hour, and in Italy considerably less than one hour.

Nebraska Telephone Association to Lincoln Feb. 20-22

Lincoln, Neb.—The annual convention of the Nebraska Telephone association will be held at the Lincoln hotel, Lincoln, on Tuesday, Wednesday and Thursday, Feb. 20, 21 and 22. Among the officers of the organization are Bruce Brown, of Brady, president; George E. Becker, of Pawnee City, and Warren Pratt, of Kearney, vice presidents; A. W. Forbes, of Stanton, secretary and treasurer.

Bell System's "Moving Bill" Put at $20,000,000 Yearly

New York, N. Y.—The so-called "moving bill" of the Bell telephone system is put at $20,000,000 a year. This includes relocating poles and telephone installations. It is estimated that the company makes 2,400,000 installations each year and 1,800,000 disconnections. A part of this enormous outlay is taken care of by service charges.

Supreme Court Puts O. K. on Guy Wires in Nebraska

Lincoln, Neb.—The supreme court of Nebraska, in a recent decision, held that a public service corporation has a right to use guy wires in streets and alleys where required so long as the wires are placed in a way that will not endanger public travel or the safety of individuals.

Radio a Supplement to Wire

Telephone Man in Smaller Towns the First Friend of the Wireless Fan—Experience Gives Him Advantages —Possibilities of Wire-Wireless Coming Development

By R. T. Cloud

Several years ago amateur radio operators in and around New York City, were surprised to hear the strains of the Star Spangled Banner in their receivers. As their ears were accustomed to hear nothing other than the telegraphic code their surprise can be imagined. Yet what they heard was not the radio phone as we understand it today. The explanation of the phenomena came out when the papers the next day, carried the story that the Prince of Monaco had installed on his private yacht, then in the harbor of New York, a sort of radio piano.

It is customary on spark sending sets to break up the spark with a toothed wheel rotated by a motor, and the number of interruptions per second give the radio wave a distinctive musical tone. By means of a number of these wheels and a device for switching the spark from one to the other he was able to send music.

While this was a novelty and undoubtedly gave pleasure to the comparatively small number of listeners still it did not create any popuar interest in radio. Even the perfection of the radiophone during the war and the establishment of many amateur radiophone stations did not greatly increase the public interest in this device. It was only after the advent of the broadcasting station with a regular service that the wave of popularity set in, and receiving stations in large numbers began to be installed.

Will Broaden Education

While the majority of the people install receiving sets primarily for amusement, the greatest benefit derived will, undoubtedly, be educational; not only teaching proper appreciation of good music but along many other lines of education. Already, many of the broadcasting stations are putting out talks and lectures of an educational character by the foremost authorities in the country.

Many people will listen to these talks and profit thereby where they would not spend time in reading the same article.

Noteworthy are the weekly lectures by members of the faculty of the University of Chicago, embracing features of science and education delivered along popular lines. These lectures, are appreciated by many who have had few educational advantages and it would be difficult to estimate their value to the public at large.

Many of the state educational institutions are giving regular lecture courses from their broadcasting stations. These consist principally of talks on agricultural subjects. Provided that these lectures reach a sufficient number of farmers, the result should be greater and better production of necessities of life, with consequent benefit to the welfare of the country. The end is not yet in sight for every day brings some new application of this wonderfully useful agency for the distribution of information.

Wire Lines Won't Suffer

Practically all authorities agree that radio will supplement, rather than supplant, the wire telephone; the wire telephone will be used for person to person service, except in isolated cases, such as Avalon-Los Angeles circuit and in ship-to-shore service. The principal service of radio will be for the distribution of general information as at the present time. This service will be improved, of course, so that a person can select, at will, such program or lecture as he desires, at any time or place.

At the present time, there are plenty of broadcasting stations and it would seem to be desirable to decrease the number, if the decrease will bring improvement in the class of programs and perfection of quality of transmission. Undoubtedly, the existing demand for broadcasting will assure its continuance and the great problem seems to be in making the programs available to the majority of the people.

The cost and expense of maintenance of receiving sets capable of receiving over long distances is beyond the means of the majority who would benefit most from this service. This is particularly true of people who are isolated on farms and in small towns, where the long winter evenings drag. Here is the place where radio will render a service of inestimable value.

One of the means by which the telephone man could be of service to his community would be the relaying of programs to his subscribers. Under one plan a receiving set capable of receiving long distances can be installed at the central office to receive the best programs and then relay them at audio frequency, using the regular telephone instruments. However, there are several draw-backs to this plan. It would tie the lines up for regular service which is, after all, the principal business of a telephone company, also, ordinary telephone apparatus is not adapted to the transmission of music. Being designed for voice transmission only, the overtones and higher notes would not be transmitted satisfactorily.

An alternative plan would be to make use of the wired wireless system, using the wires of the telephone plant to guide the waves. By the use of comparatively simple and cheap crystal rectifiers, the programs will be made available to subscribers without in any manner interferring with regular service. Of course, there would be several problems to be met in arranging apparatus for this purpose, among them being the preventing interference from local apparatus in the exchange, ringing machines, pole changers, etc., and the prevention of theft where charges are made for such service. That these difficulties can be overcome is probable, however.

Field for 'Phone Man

It would seem that the telephone man is particularly suited both by training and experience to solve the many problems involved in making this service available to the community. It is significant that many of the developments that make for the perfection of present day broadcasting are products of the telephone research laboratories.

With the rapid progress of this art, there is not only work for the engineer but for the rank and file worker. In every small town, the local telephone man is regarded as an authority on matters electrical and the people there will naturally turn to him for advice and services in purchasing and maintaining a radiophone

(Continued on Page 44)

OPINIONS AND COMMENTS

MANAGERS WE'VE KNOWN

In a certain town lives a telephone executive who gives evidence of his Quaker ancestry by the possession of the many splendid qualities that have distinguished the adherents of that form or religious belief. His kindliness of manner and wholehearted interest in his fellow men bespeaks the influence of his early training under a rule of life that stresses strongly the virtue of brotherly love.

A kindly, upstanding man, he has the respect of himself and of his community but he does not understand that brotherly love requires that he should accept slighting remarks without a word of gentle reproof given in a friendly fashion. The story of one of the occasions on which he felt that such reproof was necessary is worth retelling as it indicates the feeling of the man toward the business in which he is engaged.

A short time before the incident occurred, this telephone man had purchased a new desk of which he was quite proud. A farmer subscriber of his company came into the office one day and seeing the new desk remarked, "That's a fine desk you have. Why, that is good enough for a banker!"

"Friend," said the telephone man, "do you know that the Blank Telephone Co. has invested more than a third of a million dollars in this territory and in this exchange alone has more money invested than the capital stock of any bank in the county. Every month we pay out more in wages to our employees than any other business in town with one exception and we probably pay out as much as all of the banks put together.

"Do you know any good reason why I, as president of the telephone company, should not have as good office furniture as any banker or any other business man?"

It is not necessary to speculate about the feelings of the subscriber, but it is worth while to comment upon the fact that here is one man in the telephone business who has the right perspective of its place in the community.

The telephone business is a big business. In fact it is one of the biggest businesses in any community, a fact someimes not recognized by telephone managers whether they be employees of a large company or owners and managers in the smaller exchanges. One of the things needed within the industry is the type of understanding displayed bv this executive of the real place of the telephone company in the business world.

VISION A BUILDER

Development of the telephone industry in the United States would not have been possible without vision of the future.

In this issue you can read something of Frank Gill's vision for it in Europe.

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IDEAS IN FINANCING

The new undertaking of the directors of the United States Telephone Association in planing a financial organization to assist member companies that are in financial distress is a move in the right direction. Undoubtedly many companies are in a condition where they can be much benefitted by such a movement.

Within the next few years large amounts of new capital will have to be poured into the telephone companies of the independent group if they are to continue to grow and to improve their service. Many plants are reaching a stage where they are emerging from the status of a small business and must prepare to do things in a bigger way.

To do this means additional investment and improved construction and operating methods. These things can not be secured without money and the securing of the funds is a matter of prime importance. In a business where the annual turnover is only a small percentage of the capital invested, funds for development must come from outside the business if the business is to grow.

It is neither necessary nor desirable that the locally owned telephone company should go to the money centers of the country to secure the funds needed. The strength of the independent telephone company lies in the fact that it is a home institution financed by local capital and managed by people who are residents of the community where it does business. When it loses this characteristic much of its hold on the sentiment of its subscribers will be lost.

That the funds for development can be secured without going outside the territory in which the company operates has been amply proven. The Bell company itself has shown this by the

successful placing of millions of dollars of the stock of subsidiary companies among their subscribers. In fact a considerable amount of the financing that has been done recently has been done in this way instead of by borrowing from bankers.

Independent companies should be able to secure capital in this way even more easily than the Bell has done. The difficulty is that independent managers are not trained financiers and are not equipped to handle the job of selling securities. What is needed is someone to point the way and if the proposed financial organization can furnish advice and assistance the problem of financing should be well on the way toward solution.

NEW RADIO WONDERS

Scarcely a day passes without a report of some new wonder that has been performed by the radio-telephone. The latest news is the story of the experimental transmission across the Atlantic ocean. The success of the experiment is indicated by the fact that transmission was continued for several hours without interruption.

While two-way transmission was not attempted as the necessary station equipment was not available at the terminal in England there seems to be no doubt that it will be successful as soon as a transmitting station is installed.

As the story of each new achievement comes to us we are compelled more and more to admire the engineering skill that has accomplished so much in the relatively short life of the radio-telephone.

At the same time the use and the limitations of the radio-telephone are becoming better known and the direction of the trend of development is becoming clearer so that we may soon hope to be able to judge the place that it will take in the general system of communication in use over the world. Just at present that trend seems to be away from point to point communication over land instead of toward it.

POLE LOAD DATA

Comments have appeared occasionally in these columns on the need of better engineering in pole line construction. The chief idea is to lessen the number of failures, especially during sleet storms. Attention has been called to the lack of reliable data relative to overloads and other conditions that may be expected.

In this issue we are able to present information. It is a welcome addition to the scant store now available in published form.

It does not often happen that it is possible to observe the action of a heavy ice load upon a pole line under conditions where no lateral forces due to wind pressure are present. The Forest Service has done a useful piece of work in studying the causes of failure of poles in the Wisconsin storm of February, 1922, and in publishing the results of its investigations.

Some of the outstanding facts brought out are that the failures are caused by bending and that the compression due to dead load can be neglected in computing stresses in pole lines. It is also definitely established that occasional strong poles or even H-fixtures in the line do not possess sufficient strength to enable the line to stand up under heavy ice loads. Guying in the direction of the line is the most effective means of preventing entire lines from collapsing.

There is a real need in the telephone industry of more published information of the type given in the article by Mr. Heck. Such information is the sine qua non of the design and construction of pole lines on a sound engineering basis.

UNHONORED; UNSUNG

In times of war when nations are aflame with a blaze of patriotic enthusiasm, every man who wears the uniform is a potential hero whose deeds may find a place in the history of his country and whose sacrifices may become the theme of song and story. Men are inspired to perform deeds of conspicuous bravery or heroic self-sacrifice by ideals of patriotic service and they are honored accordingly.

Times of peace also have their heroes but too often their efforts in behalf of an ideal of service are unnoticed and their stories are untold. No strains of martial music and no cheering multitudes speed them on their way when duty calls but they go unhesitatingly and with no thought of personal comfort and convenience. No honor comes to them and their only reward is that feeling of satisfaction that comes from work well done.

There is nothing romantic about the lineman with his equipment of belt and climbers and there is little about his rough exterior to indicate the metal of the man within. But when storms come, when snow and wind and ice break down the threads of copper and iron that link together the communities where men dwell the real man appears.

No snow is too deep, no road is impassable, no obstacle is too great to bar him in his iron determination to restore service whatever the cost. Hours of labor mean nothing and only complete exhaustion can stop him before his work is finished. He knows no rest until he has accomplished his task of restoring the wires so that the service may go on.

Like all men of truly heroic mould he expects no personal glory and usually none is given him. He is embarrassed at even a word of commendation from his superiors and passes it off with the comment that it "is all in a day's work."

Like the old sea dog in one of James B. Connolly's stories, he contents himself with the thought, "Well, anyway, you've had the satisfaction of doing a good job."

Jealousies between the nations of Europe have delayed the growth of telephone service. Diversity of languages has been a barrier.

Hatreds and suspicions have held up development. It may be that the time has come for the telephone to soften this barrier.

MINNESOTANS MEET

Telephone Association Holds Its Annual Conference and Elects Chiefs

St. Paul, Minn.—The Minnesota Telephone Association closed a three-day session at the Ryan Hotel, St. Paul, on January 25. Many problems were discussed including those of finance, liability insurance, service and engineering.

Officers were elected as follows:

Jay Greaves, Glencoe, Minn., president, re-elected; E. P. Wright, Alexandria, and D. W. Gretorex, Blue Earth, vice presidents; J. C. Crowley, St. Paul, secretary and treasurer. Directors were named as follows: D. M. Neill, Red Wing; Thomas Vollom, Erskine; Jay Greaves, Glencoe; Herman Lueders, Norwood; Well S. Clay, Hutchinson; E. P. Wright, Alexandria; Irving Todd, Hastings; D. W. Gretorex, Blue Earth; C. M. Smallwood, Worthington; and P. M. Ferguson, Mankato.

President Greaves, in his opening address, outlined his ideas of the object and function of the association in the following words:

1—It should seek continually to improve the telephone business as such, and constantly bring it up to an ever higher standard of efficiency, service, and usefulness.

2—It should seek to bring together and unite all the interests engaged in the business in such a way that they can stand and act together for their mutual protection and for the good of the industry as a whole.

Mr. Greaves said that he felt confident that the association, by the work it had done on behalf of the industry in general, had fully justified itself. In the year, he added, nineteen district conferences had been held which were attended by more than 800 men vitally interested in the telephone industry.

The need of liability insurance was outlined by Walter L. Clark, of Marsh & McLennon, of Minneapolis. He told of one case where a wire stretched and sagged across a road. A man driving along the road was jerked from his wagon and permanently injured.

The telephone company was held liable and a verdict was given the man in court for $8,000. This happened in Minnesota. He told of other cases in other courts. He said that public liability insurance should be carried for the following reasons:

1. To indemnify the telephone company against loss by reason of the liability imposed by law upon the company for damages on account of bodily injury, including death at any time resulting therefrom, accidentally suffered or alleged to have been suffered by any person or persons not employed by the assured.

2. To investigate all accidents reported by the telephone company.

3. To defend, in the name and on behalf of the telephone company, such suits, even though groundless, brought against the telephone company to recover damages on account of personal injury accidents.

4. To pay, irrespective of the limits of the insurance carried, all costs taxed against the telephone company in any legal proceeding defended by the insurance company, and interest accruing after entry of judgment.

5. To pay all expenses incurred by the telephone company for such immediate medical or surgical relief as is imperative at the time of the accident.

P. M. Ferguson, of Mankato, led a discussion on the subject of "Collection Methods and Policies," which was participated in by C. M. Smallwood, of Worthington; Ed. Hanley, of Welcome; W. E. Leasman, of Madison; J. W. Heritage, of Amboy; G. L. Wilder, of Granite Falls, and others.

C. M. Babcock, state highway commissioner, spoke on the subject "Co-operation Between the State Highway Department and Telephone Companies." Mr. Babcock outlined the development of the 7,000 miles of Minnesota state highways.

George W. Rodormer, of Chicago, secretary and sales manager of the Reliable Electric Co., read a paper on "Station and Plant Protection." It was followed by considerable discussion, in which many points of interest were developed.

"Causes and Effects of Inductive Interference," was the subject of an interesting blackboard talk by N. W. Kingsley, of Minneapolis. This talk drew forth many questions which were answered by Mr. Kingsley.

Thomas J. Phalen, of Aberdeen, S. D., secretary of the South Dakota Telephone Association, was introduced by President Greaves, and outlined the work being done in South Dakota. He mentioned several laws in South Dakota that are of material benefit to the companies in that state.

A resolution was passed as follows:

"Whereas, the telephone industry has grown to be of major importance in the commercial and social life of the people, and that this involves, greater responsibility upon owners and managers.

"Be It Resolved, that we urge upon all owners and managers the ever-increasing necessity of being continually on the alert to improve their equipment and methods of handling their business, to better their relations with the public, and to use their utmost endeavor to render to their patrons a more efficient and satisfactory service, and thus add to their own standing in public esteem."

N. Y. RATES REVISED

State Commission Orders Up-State Cuts But Increases New York City Charges

New York, N. Y.—The public service commission of New York on Jan. 25 handed down an order which calls for a trimming of telephone rate charges up-state. At the same time it ordered a revision upward of toll fees in Greater New York.

In a nutshell it may be said that the telephone companies in the rural districts will lose $500,000 a year while the New York lines are given $2,000,000 more annually. Following are some excerpts taken from the statement handed out by the commission:

"Today's order provides for a revision of all rate schedules in New York City; effects decreases for small users estimated at $250,000; increases rates for large users amounting to about $2,500,000; decreases flat rates in effect in Brooklyn by about $75,000; increases the long haul inter-zone toll rates in Greater New York; equalizes disparities in existing rates to flat rate users in certain classes of service in residential boroughs, and makes a decrease in toll rates to suburban areas adjoining Greater New York with consequent elimination of the federal tax on such messages, estimated to be $300,000.

"The company is directed to print all New York state directories, except the New York City, general suburban, Westchester district, Albany, Buffalo, East Aurora, Lockport and Syracuse, with a two-column page instead of the three-column one now in use.

"All advertising matter contained within the body of the printed listing in the directory is ordered discontinued. A recommendation is made that only two issues of the directory be made in New York City, beginning in 1924.

"The increases of rates in New York City will add approximately $2,500,000 to the revenues of the company, while there will be a loss in revenue of approximately $500,000 as the result of the reduction granted to small users.

"Subscribers who use 140 messages a month or less," says the commission in regard to New York City rates, "will pay a lower rate than at present, and the increases fall mainly upon those who use the service in greatest volume. The new schedule should aid rather than check development, and subscribers to business service, to whom the value of the service is greatest, will pay a more equitable proportion of the company's revenue requirements."

Practical Plant Problems

Chapter XI—Interior Block and Cable House Systems

By Charles W. McKay, Associate Editor*

At first thought it may seem strange to the reader that interior block and cause cable distributing systems are grouped in the same general category as the underground cable plant—rather than under a separate classification such, for instnce, as "aerial cables." The reason will be obvious from the following historical sketch.

First, let us review the instructions of the Interstate Commerce Commission, with respect to account No. 245, "Exchange Underground Cables." The instructions follow:

"This account should include the cost of exchange service underground cables, including cable boxes and fittings, loading coils, and other materials used in the work of installing such cables, and other costs incident thereto.

"It should include, in addition to the main exchange underground cable, the subsidiary cables through laterals to pole or building terminals; the subsidiary cables to the interior of city blocks for connection with interior block wires; and the subsidiary cables entering vertically—as house cables—into buildings for connection there with the inside wires.

Considered Vertical Extensions

"House cables are considered to be vertical extensions of underground cables or plant similar thereto. They do not include the inside wires extending from terminal boxes of house cables to subscribers' stations, nor the cables for subscribers' private branch exchange switchboards, which are included in Account 232, Stational Installations."

The foregoing quotation shows, quite conclusively, how the Interstate Commerce Commission considers **all** branch cables—including house and block cables.

In the early days of the art of telephony—even before the Interstate Commerce Commission was established—house, or block, cables were almost unknown. At that time,—in instances where the aerial cable mode of distribution was not employed, a lateral, or branch, cable would be extended from a manhole to the interior of a city residential or business block; a very high pole (often from 50 to 65 feet in height) would be placed at about the geographical center of the block and a branch cable extended to the top of the pole.

Standard Practice Provisions

Standard practice provided for the termination of this branch cable in an especially constructed fixture—consisting of a protected terminal surrounded by a circular wooden platform. An especially designed guard rail encompassed the platform—this rail being placed at about 3 feet above the platform. The railing served two purposes—first, it served as a protection to men working on the terminal platform, and second, it provided a means of distribution. The rail was pierced by holes at intervals of a few inches; bolts were placed in the holes and to either end of the bolts were attached insulated distributing knobs (usually porcelain knobs).

The drop wires, used to supply service to the subscribers within the city block, were spanned directly from the knobs to the subscriber's premises—provision being made for extending the drop wires (in the other direction) from the knobs to the line side of the protector equipment enclosed within the terminal box.

Imagine the difficulties involved in maintaining an interior block distribution system of this nature! The wires would become heavily weighted with ice and snow in the winter time—causing breakage and interruption to service. Furthermore, the clearing of trouble at the top of a 55 ft. pole is no "cinch"—as the writer can testify from his own experience. In many cases, the load imposed by the subscribers' drop wires, together with the natural deterioration of the poles from age, resulted in an extremely dangerous condition—not only to the employees of the telephone company (who were obliged to climb the poles) but also to the surrounding residents.

This old "circle-top" (as it is often called) mode of interior block distribution, is really the forerunner of the modern house and block cable method of serving the subscribers located within the boundry of a city block. The cable system was really a minor extension of the underground cable plant—and it is probably for this reason that the practice of classifying block, and house, cables as a portion of the exchange underground cable account was first inaugurated.

Needless to say, the old "ring" or "circle-top" distribution system had its limits—as to capacity. Furthermore, these high poles equipped with their umbrella-like drop wire structure, were anything but presentable, from the standpoint of appearance, and were frequently objected to by surrounding property owners.

There is an old saying that "necessity is the mother of invention" and when the telephone companies found that the circle-top type of distribution would no longer serve the purpose, adequately, the present interior block system of cable distribution was evolved. In the interior block system a relatively short lateral cable is extended from the nearest subway manhole to a point just within the city block—where it is either terminated in a cross-connection (or straight-connection) terminal box or spliced directly to the block cable system, dependent upon the exigencies of the case in question. Sometimes the point of termination of the underground branch cable (and hence the point where the block cable starts) may be located in the cellar of a building—or, again, it may be in the back yard of a residential property.

Affected by Construction

In New York—and in the older portions of many other cities—where the closed type of building construction prevails, the block cables may be extended along yard fences or along rear building walls. In other cases—where the open type of building construction prevails—(in other words, where all residences or apartments are separated by a side yard or passageway) short interior block poles may be used in lieu of the "back fence" type of construction.

As an illustration of the latter type

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of construction—in certain portions of suburban New York, the houses are all detached and rear fences are dispensed with entirely—leaving an open space in the interior of the block. In such instances, interior block distribution is effected by the use of 11-foot poles (either wooden or concrete), cables, terminals and so forth being attached to these poles.

In connection with the discussion of the block cable mode of distribution, it is interesting to note that, some fifteen or sixteen years ago one of the large Bell telephone companies mapped out an engineering program which involved the installation of an interior block cable in practically every city block—regardless of the character of the property or the ultimate number of subscribers expected. In other words, this company went from one extreme to another.

Cost Is a Factor

As fast as the old circle-top distribution systems were abolished, elaborate and expensive interior block cable systems were installed. The company soon found, however, that there was a limiting factor to be considered—that the expense of installing interior block cables was only justifiable in instances where the fundamental plans and engineering studies indicated, clearly, that an appreciable volume of business might be expected. In all other cases, residential subscribers were served by aerial cables installed upon alternate streets.

Most of the foregoing discussion has to do with the type of city block where longitudinally bisecting alleyways are non-existant. In most of our Midwestern towns and cities alleys are found and it is, of course, both feasible and advisable to serve the residential districts by means of pole lines placed along the alleys. Business blocks (by "business," in this instance, we refer to the smaller office buildings and shops), may be served by cables placed along the rear building walls.

Block cables are expensive and it is most important that they shall be carefully designed in advance of installation.

In connection with the serving of subscribers within city blocks, we also have another, and a very serious one, to consider—the house-cable problem. Especial cable systems must be installed in the larger buildings—both apartment buildings and office buildings. These cables are usually known as "house-cables."

In accordance with the foregoing suggestion, house-cables may be divided into two general classifications —those serving commercial and office buildings and those serving hotel and apartment buildings.

There is a very real engineering factor involved in the design of a house-cable system. It is usually possible to determine, in advance, the number of telephone stations per square foot of floor area for office and commercial buildings. In hotels and apartment houses it is pretty safe to count upon one telephone subscriber per apartment, or per room—according to the nature of the apartment or hotel under consideration.

We will first take up the consideration of office buildings. For purposes of illustration, we may assume that we are considering a very large and important building—we may assume that two "trunks" or lines will be required for every office. Obviously, it is impossible to ascertain—in advance—the exact location of all subscribers' stations. Business men are inclined to be very "fussy." They often have pre-determined ideas as to just where and how a telephone should be installed. Hence, in laying out an office building system, it is necessary to make the system as flexible as possible.

The engineer first determines the number of lines, as nearly as possible, that will be required for each floor. In some cases—when buildings are very large—several vertical cables (known as "risers") will be required. The engineer must ascertain the approximate number of lines that will be required on each floor for each riser.

Led in From Manholes

The cable is led into the building from the nearest manhole, and, as a rule, is terminated in a large cross connection box. Some companies do not use cross connection boxes—because of the cost of maintenance. However, it will be readily seen that an intermediate point, where the house cable pairs can be cross-connected with the feeder cable pairs, is a distinct advantage. In our present case, we will assume that a cross-connection box is used, and that the feeder cable is terminated in this box.

To simplify our illustration, it has been assumed that only one riser is required for the building under consideration. The first floor can be wired directly from terminals on the walls of the basement. These terminals are spliced to a cable which terminates directly in the cross-connection box. Likewise, the second floor may be cared for by means of a cable which terminates directly in the cross-connection box—thus obviating the necessity of a larger riser cable between the first and second floors.

It may be assumed that a 400-pair riser cable extends to the fourth floor; a 300-pair to the seventh floor; a 250-pair to the tenth floor; a 150-pair to the thirteenth floor and a 75-pair to the sixteenth floor—while at the sixteenth floor, the "riser" is split up into three 25-pair branches, one going to the fifteenth floor, one feeding the sixteenth floor and one extending to the seventeenth floor.

Architects More Helpful

In connection with the installation of cable systems for hotel and office buildings—it may be said that, up until ten years ago, telephone engineers had a hard time to induce architects and builders to provide adequate facilities for telephone service. While the architects were perfectly willing to provide facilities for electric light, gas and water service—they, the architects, seemed to feel that the telephone was not very important and could be cared for in almost any way whatsoever. An educational program was adopted, about ten years ago, in most of the towns and cities—with the net result that architects and building engineers are now only too glad to provide for telephone facilities.

Leaning toward electric light practice, architects are inclined to provide conduits for riser cables. Shafts are much better—as they allow the men plenty of room for working on the cables. If the shaft is large enough the cable can be formed and spliced on the roof of the building; lowered into place and subsequently attached permanently to a wall in the shaft. Such attachment can be made by a man lowered in a "boat-swain's" chair from the roof of the building. If the shaft is small, the cable can be lowered into place in sections, and spliced at the various floors—or splicing points.

Needless to say, it is not necessary to provide for party line service in office buildings. Every subscriber will require at least one line. Having determined the line requirements—the engineer can lay out a theoretical cable system—somewhat along the lines suggested in the foregoing illustration.

In the March issue, block and house cable plans will be discussed more in detail—giving practical illustrations.

Butte, Mont.—The Mountain States Telephone & Telegraph Co. has just completed a $35,000 test room here.

ALTERNATING CURRENTS (EE-9-25)

SKIN EFFECT IN CONDUCTORS

ELEMENTS OF SKIN EFFECT. When an alternating current passes through a conductor, the current density is unequally distributed, the current being heaviest near the external surface or "Skin" of the conductor and decreasing in density as the center is approached. With large wires the central portion of the conductor is nearly useless as a conductor, and as the effective area of the wire is thus reduced, its resistance is increased and its carrying capacity is diminished. The carrying capacity of such a wire is far below its capacity when carrying a direct current. This is called "Skin Effect."

To obtain the least skin effect for a given weight of conductor it is therefore advisable to increase the superficial area of the wire and to decrease the cross-sectional area of the metal near the center. As a stranded cable has a greater superficial area than a solid wire of circular cross-section, the cable gives greater carrying capacity and less resistance than the solid conductor. In high frequency work, where losses by skin effect are very high, this idea is carried further by employing flat metal strip, square wire or "Litzendraht" cable, the last consisting of a stranded cable built up of wires, each strand being covered with enamel insulation so that it acts as an independent conductor and therefore enormously increases the effective superficial area. A hollow tube or hollow wire offers less resistance per pound foot than a solid conductor, and as a triangular section has greater outside area per outside measurement than any other geometric form it is almost an ideal form for very high frequency currents.

The skin effect increases with the frequency and the diameter of the wire (Squared), the loss being very small for ordinary power frequencies of 25 cycles per second, larger for 60 cycles per second and still larger for 133 cycles. With frequencies above 1,000 cycles per second the current lies mostly in the skin of the conductor. A large number of small wires is more economical from this standpoint than a large single conductor of equivalent cross-sectional area. The effect increases with the square of the conductor diameter, and the complete relation may be expressed by:

$$\text{Frequency} \times \text{Diameter}^2 = \text{Constant}$$

The following table contains convenient factors for computing the skin effect at the usual frequencies employed in commercial circuits, the factors taking the frequency and diameter into account.

SKIN EFFECT FACTORS

(Standard Underground Cable Company)

A =	25.00	35.00	43.00	49.50	56.50	71.50	84.50	96.00
B =	1.02	1.04	1.06	1.08	1.10	1.15	1.20	1.25
A =	108.00	130.5	154.5	178.50	204.00	232.50	263.5	294.00
	1.30	1.40	1.5	1.60	1.70	1.80	1.90	2.00

In this table we have the following values for the factors (A) and (B):

$$A = \text{Diam.}^2 \times \text{Frequency} = \frac{\text{Circular Mils}}{1{,}000{,}000} \times \text{Frequency (Diameter in Inches)}$$

B = Multiplying Factor

To find the factor with which the resistance to the direct current is to be multiplied, in order to obtain the resistance to alternating currents, multiply the number of circular mils by the frequency and divide by 1,000,000, then find the result in line (A) between two of the nearest numbers in the table. The required factor on line (B) lies between the factors corresponding to these two numbers, and the exact result is then obtained by interpolation. EXAMPLE: Find the resistance to an alternating current, 133 cycles per second, 850, circular mils, the cable offering a resistance of 0.001157 ohms to direct current.

$$\frac{\text{Circular Mils} \times \text{Frequency}}{1{,}000{,}000} = 0.85 \times 133 = 113 \text{ (A)}$$

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ALTERNATING CURRENTS (EE-9-26)

SKIN EFFECT IN CONDUCTORS (Cont'd)

Having obtained the value of (A) as 113, we refer to the table where we find that the result lies between 108.0 and 130.5, the difference between the last two amounting to 22.5. This corresponds to a difference in the corresponding (B) factor of 1.40 — 1.30 = 0.10, and since the difference between 113 and 108 is 5, we have by simple proportion:

$$0.1 \times \frac{5}{22.5} = 0.02, \text{ the increase in the factor above } 1.30$$

corresponding to the increase in the numbers in line (A) from 108 to 113, so that the factor corresponding to 113 is: 1.30 + 0.02 = 1.32. Multiplying this by the resistance to the direct current, we have: 0.001157 × 1.32 = 0.001527 ohms as the resistance against alternating current. It should be understood that the above computation holds for solid wires of circular section only and for any other section different factors must be used. The equated resistance found above can be used in connection with formulae on self-induction and capacitance when finding the total resistance, ohmic and inductive.

DIRECT CALCULATION. In cases where the table just given does not cover the desired range of frequencies, the following approximate formula can be applied for the calculation of skin effect.

$$r = R\left[1 + \frac{1}{12}\left(\frac{2nfL}{R10^9}\right)^2 - \frac{1}{180}\left(\frac{2nfL}{R10^9}\right)^4 + \ldots\right]$$

In this equation r=resistance offered to an alternating current, R=resistance offered to an alternating current, f=frequency in cycles per second, and L=length of the conductor in centimeters.

It will be noted that the reciprocal 1/R is proportional to the cross-sectional area of the conductor as in the first method described. While the cross-sectional area is of importance in skin effect, and must be kept as small as possible in the usual copper or other non-magnetic conductors, particular care must be taken to keep the diameter of magnetic conductors down to the lowest limits. It must be considered seriously in circuits where iron or steel acts as a conductor. Skin effect reaches a high value in iron wire circuits at telephonic frequency.

SKIN THICKNESS. Gray and Lord Kelvin computed the thickness of the skin or "shell" of current in an alternating current circuit, and a few of these values are tabulated below for a few different frequencies, both for copper and for iron conductors. It should be noted how the magnetic material pinches down the effective skin thickness compared with the copper conductor, and how necessary it is in magnetic material to extend the surface as much as possible. This table applies only to solid circular sections.

THICKNESS OF SHELL ON CYLINDRICAL CONDUCTORS

Frequency in Cycles Per Sec.	Thickness of Shell in Centimeters	
	Copper	Iron
80	0.719	0.0976
120	0.587	0.0789
160	0.509	0.0691
200	0.455	0.0671

At radio frequencies, ranging from 100,000 to 1,000,000 cycles per second, the current shell is exceedingly thin and any little change from a circular cross-section instantly meets with a reduction in resistance losses. For example, the change from a circular No. 14 wire to a square section No. 14 increased the receiving radius of one set by about 50 miles without making any other changes. Very thin flat strip gave even better results, but care had to be exercised so that the capacitance was not greatly increased at the same time.

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Valuation in Rate Making

Chapter XI—Unit Costs (Continued)

By Charles W. McKay, Associate Editor *

In the January installment we considered ways and means of evolving the unit costs for exchange and toll pole line equipment and also for the aerial wire plant. In the present installment we will consider the problem of aerial and underground unit cost derivation.

Considering first the aerial cable problem—it may be well to review the instructions of the Interstate Commerce Commission as to what should be included with the aerial cable plant. To paraphrase these instructions, the aerial cable accounts should include the costs of cables, including the costs of suspension, strands, clips, rings, or marlin ties (used for attaching the cables to the strands); the cost of cable boxes, pole seats and platforms, loading coils, potheads, protector equipment, sleeves and all of the miscellaneous material used in installing the aerial cable plant. Needless to say "cost" in this case means "cost in place"—or "cost installed"—as a part of the working plant.

To conform to our original hypothesis—that of a reproduction cost, appraisement made on the basis of five year average costs—it will, of course, be necessary to make a careful analysis, first of all of the component elements of material cost and second of the labor items.

With respect to the materials, every effort should be made to determine the actual costs—as ascertained from the Company's books, records and invoices. In this connection, it should be noted that "quality purchases", only, should be considered. In other words, if we are determining a five-year average material cost for a 25 pair cable and we find that only a small amount of this cable was purchased during certain of the years included within the five year analysis period—it would, obviously, be most unfair to include these "small quantity" purchases. This, for the reason that profitable purchases can only be made where relatively large quantities are involved. Insofar as the material cost elements are involved, therefore, the problem resolves itself into one of ascertaining all possible data from books and invoices for quantity purchases and supplementing the missing information by obtaining direct quotations (if possible on a competitive basis) from manufacturers of the equipment in question. These quotations, of course, should be on the basis of "quantity purchases" comparable with the quantities involved in the plant under consideration.

To illustrate—if we are confronted with the task of evaluating 10,000 ft. of 25 pair cable and quantity prices (as obtained from the books and invoices of the company) are available for only three of the years included in the five year analysis period—we should obtain manufacturers' quotations for 10,000 ft. of 25 pair cable for the other two years.

In building up the labor unit costs, the same general plan is adopted as the one described in connection with the pole and wire unit costs. A theoretical gang is assumed—all assumptions as to the gang make-up being predicted upon past actual experiences

Items	Cost Data: 5/16-inch Strand	3/8-inch Strand	1/2-inch Strand
1000 feet strand			
10 machine bolts			
10 messenger clamps			
2 2-bolt clamps			
2 thimbles			
Totals			
Wasted loss of 2%			
Total material			
Total labor			
Unit cost per 1000 feet			
Unit cost per foot			

Fig. 20
Illustration of Method of Evolving Unit Costs for Messenger Strands

Number of Pairs and Type	Material: Cost of Term	Cost of Mounting, etc.	Cost of Cable "Leg"	Cost of Pothead	Cost of Misc. Material	Total + 2%	Labor: Placing Terminal on Pole	Assembling Terminal	Making Up Pothead	Total Direct Labor	Supervisor at 15%	Total Labor	Total Unit Cost
25 pair—protected													
10 pair—unprotected													
15 pair—protected													
25 pair—protected													
50 pair—protected													
Etc.													

Fig. 21
Illustration of Method of Evolving Aerial Cable Unit Costs

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Size of Cable	Gauge of Cable	Material (Includes Waste and Loss Allowances): Cable—1000-Foot Lengths	Material: Splicing Material	Material: Total Material	Labor: Teaming	Labor: Pulling Cable	Labor: Splicing and Testing	Labor: Supervision at 15% of Direct Labor	Labor: Total Labor	Total Cost per 1000 Feet of Cable	Unit Cost per Foot
25 pair	22 B. & S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
50 pair	22 B. & S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
100 pair	22 B. & S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25 pair	20 B. & S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
50 pair	20 B. & S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
75 pair	20 B. & S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
100 pair	20 B. & S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
50 pair	19 B. & S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
100 pair	19 B. & S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Etc. (for various sizes and gauges of cable as found in Plant)		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Fig. 22
Illustration of Form for Computing Unit Costs of "Made-Up" Terminals

and the amount of work that this gang can do in a given period is estimated as accurately as possible. Subsequently, the labor costs may be reduced back to a unit cost basis.

Knowing the number of feet of a given size and gauge of cable that the gang can place in a day—under ordinary conditions—it is a comparatively simple matter to determine a unit cost per foot installed. In a similar manner, unit costs may be derived for each type and classification of aerial cable terminal and so forth.

There are two methods of deriving aerial cable unit costs. The first method provides for the evaluation, using a unit cost per foot of cable installed, including the messenger strand —while the second method provides one unit cost for the messenger strand installed and another unit cost for the cable itself. The method last mentioned is the more prevalent—for the following reason:

The ring type of construction is now considered standard practice by most telephone companies. The strand is placed first; subsequently the strand is "ridden" by a man in a "boatswain's chair" who clamps the rings in position—usually at intervals of about 12 inches and, finally, the cable is pulled through the rings in much the same manner that a cable would be placed in an underground duct. As a matter of fact, this aerial ring type of construction is often referred to as "aerial conduit".

From the foregoing, it is thought that the reason for segregating the cost of placing the strand from the cost of placing the cable itself, will be obvious to the reader.

Fig. 20 illustrates the method of computing the cost of placing the "aerial conduit" complete—including strand, rings, bolts for attaching the strands to the poles, thimbles for "dead-ending" the strand and so forth. In considering Fig. 20, it will be assumed that all of the work involved in making the five year average material and labor cost studies has been completed and that only the resultant data is presented in the figure. For convenience, several types and sizes of strand are included in one unit cost set-up—as shown in Fig. 20.

Number of Pairs	Type of Terminal	Average Size of Cable to which Terminal is Spliced	Cost of Terminal (Complete)	Splicing Cost	Total Unit Cost
10 pair.....	"A"	.....	.....	.....	.....
15 pair.....	"B"	.....	.....	.....	.....
25 pair.....	"C"	.....	.....	.....	.....
50 pair.....	"D"	.....	.....	.....	.....

Note:—The "Cost of Terminal" will correspond with the "Total Cost" in Fig. 22.

Fig. 23
Illustrating Method of Evolving Unit Costs for Splicing "Made-Up" Terminals to Aerial Cables

It will be further noted that the unit costs are evolved on the basis of 1,000 feet lengths of strand; that 2% is added for waste and loss; and that the labor (this labor being the net result of the five year average gang analysis) is included as one item. The result is a unit cost per thousand feet installed of each size of strand. Dividing these unit costs by 1,000 we finally get a unit cost per foot installed—as shown at the bottom of the figure.

Figure 21 presents an analysis of the cost per foot of installing various sizes and gauges of cable. In connection with Fig. 21 it will be noted that the material items are first listed and that in the right hand portion of the figure, the labor items are listed. These labor items include the cost of pulling in the cable; the incidental costs of teaming and so forth and, finally, the cost of splicing and testing the cable.

It will also be noted that an allowance of 15% is made to cover direct supervision—as in the case of the pole and wire unit costs discussed in the last installment. In Fig. 21 all unit costs are evolved on a basis of 1,000 ft. lengths and finally reduced to a cost per foot as shown in the column at the extreme right hand portion of the figure.

Ready for Installation

Nowadays, most of the terminals used in connection with aerial cable construction are purchased ready for installation in plant. They are made up with the necessary protector equipment and a cable stub—of the proper size—is provided so that the terminal may be spliced directly into the aerial cable. However, in evaluating old properties obsolete types of terminal equipment are frequently encountered.

In these cases it is necessary to first evolve a unit cost for the terminal assembled and then an additional unit cost for splicing the assembled terminal to the aerial cable. An illustration of the cost of building up an aerial terminal, ready for installation, is presented in Fig. 22 and an example of the method of developing unit costs

for splicing the terminals to the aerial cables is shown in Fig. 23.

Underground Cable Unit Costs

According to the uniform system of accounts, as prescribed by the Interstate Commerce Commission, the following must be included in account 245—"Exchange Underground Cables:

"The cost of service underground cables, including cable boxes and fittings, loading coils and other materials used in the work of installing such cables and all of the costs incidental thereto."

In addition to the underground cable itself, the 245 account includes the cost of branch or lateral cables; the cost of interior block cables and the cost of house or building cables—and all of the appurtenances used in terminating these branch cables.

We are therefore justified in assuming that the unit cost problem—insofar as it applies to the underground cable plant, may be divided into five general classifications. These classifications are:

1—Underground cable proper — divided into exchange and toll cable in main conduit.

2—Subsidiary, or lateral, cable. These cables are the branch cables extending from the underground plant proper to poles or buildings.

3—Interior block cables—in other words the cables along the rear building walls or fences of city blocks.

4—House cables—the cables used for distribution within hotel, apartment and office buildings.

5—Central office terminating cables: These latter cables provide the termination facilities for the underground cables proper. They are, in fact, the cables extending from the pot-head splices in the central offices to the main frames and usually consist of silk and cotton, or wool, insulated cables. In the older plants one may find that the pot-head cables consist of rubber-insulated wires bound together in cable form. Such instances are not prevalent nowadays, however.

Considering the foregoing general classifications in the order enumerated —we will first take up the consideration of underground cable proper. Unit costs are developed in the same general manner as the unit costs for aerial cables, which have already been described. Five year average material and labor costs are evolved (covering the analysis period); the resultant averages are compiled in a unit cost setup, similar to the one presented in Fig. 24.

In the illustration presented in Fig. 24 it will be noted that the usual allowance of 2% has been included for waste and loss; that a column has been provided for "total material"; allowances have been made for rodding the conduit and pulling in the cable—as well as for splicing and testing the cable; the cost of teaming has been included and finally, the total labor is summed up after adding an allowance of 15% for direct supervision. The last column of the table gives the total unit cost per section. By "section" is meant the distance between manholes.

Gauge	Pairs	Splicing Material	2% Loss and Waste	Total Material	Rodding	Pulling-in	Splicing and Testing	Teaming	Total Labor with Supervision, 15%	Total Cost, Labor and Material
No. 22	25	.....	.....	.....	.....	.....	.....	.....	.....	.....
	50	.....	.....	.....	.....	.....	.....	.....	.....	.....
	75	.....	.....	.....	.....	.....	.....	.....	.....	.....
	100	.....	.....	.....	.....	.....	.....	.....	.....	.....
	150	.....	.....	.....	.....	.....	.....	.....	.....	.....
	200	.....	.....	.....	.....	.....	.....	.....	.....	.....
	400	.....	.....	.....	.....	.....	.....	.....	.....	.....
No. 19	25	.....	.....	.....	.....	.....	.....	.....	.....	.....
	50	.....	.....	.....	.....	.....	.....	.....	.....	.....
	75	.....	.....	.....	.....	.....	.....	.....	.....	.....
	100	.....	.....	.....	.....	.....	.....	.....	.....	.....
	125	.....	.....	.....	.....	.....	.....	.....	.....	.....
	150	.....	.....	.....	.....	.....	.....	.....	.....	.....
	175	.....	.....	.....	.....	.....	.....	.....	.....	.....
	200	.....	.....	.....	.....	.....	.....	.....	.....	.....

Fig. 24

***Illustrating Form for Underground Cable Unit Cost Derivation**
*Based on 335 ft. sections—exclusive of cable (material) costs.

Gauge	Size	Cable Cost per Foot	Cable Cost per 1,000 Feet	Miscellaneous Material *Section	Miscellaneous Material per 1,000 Feet	Labor per *Section	Labor per 1,000 Feet	Total Cost per 1,000 Feet	Total Cost per Foot
No. 22	25	.....	.....	.....	.....	.....	.....	.....	.....
	50	.....	.....	.....	.....	.....	.....	.....	.....
	75	.....	.....	.....	.....	.....	.....	.....	.....
	100	.....	.....	.....	.....	.....	.....	.....	.....
	150	.....	.....	.....	.....	.....	.....	.....	.....
	175	.....	.....	.....	.....	.....	.....	.....	.....
	200	.....	.....	.....	.....	.....	.....	.....	.....
	400	.....	.....	.....	.....	.....	.....	.....	.....
No. 19	25	.....	.....	.....	.....	.....	.....	.....	.....
	50	.....	.....	.....	.....	.....	.....	.....	.....
	75	.....	.....	.....	.....	.....	.....	.....	.....
	100	.....	.....	.....	.....	.....	.....	.....	.....
	125	.....	.....	.....	.....	.....	.....	.....	.....
	150	.....	.....	.....	.....	.....	.....	.....	.....
	175	.....	.....	.....	.....	.....	.....	.....	.....
	200	.....	.....	.....	.....	.....	.....	.....	.....
No. 22	25 D.W.								

Fig. 25

Form for Deriving Complete Unit Cost of Underground Cable Installed
*"Section" equals 335 ft. Three sections equal (approximately) 1000 ft.

In the case under illustration, it has been found that the average span between manholes is 335 ft. It will also be noted that in Fig. 24 no allowance has been made for the cost of the cable itself. The material items refer merely to the splicing material.

Fig. 25 takes us a step further and provides for the inclusion of the cost of the cable. All of the data incorporated in Fig. 24 has been included in Fig. 25—the cost of the cable itself being added. In the case of Fig. 25, however, the 1,000 foot lengths have been used — in other words, about three manhole section lengths. Hence, we have the cost per thousand foot of cable installed and this in the last column of the table is reduced to a unit cost per foot—by the simple expedient of dividing by 1,000.

In the March issue ways and means of evolving lateral, block and house cable unit costs will be considered.

Third Machine-Switching Office in New York in Service

New York, N. Y.—"Walker", the third of a series of machine switching telephone central offices which the New York Telephone Co. is now installing in Greater New York, was placed in successful operation on Jan. 20. This central office serves a portion of the downtown wholesale district. The new apparatus was placed in service by the transfer of 2,200 telephone stations from the Walker manual switchboard to the new equipment, about 23,000 telephones are now served from the three-machine switching offices, Pennsylvania, Academy and Walker.

Testing With Simple Outfit

Practical Telephone Man Tells in His Own Language How a Simple Voltmeter Testing Set May Be Constructed and Gives Hints for Its Use in Trouble Locating

By Fred G. Pyle

For many small exchanges operating rural lines, the cost of standard office testing equipment may be prohibitive. To meet the need of such an office, an efficient and inexpensive test board often can be built from old equipment that is to found around almost every office. The exception will possibly be the voltmeter. Aside from the voltmeter, 4 keys with two break and two make springs and a switch board, drop coil are required. Fig. 1 gives the simplified wiring circuit used in the outfit.

If the voltmeter has a resistance of 5,000 ohms or over, a 200 ohm drop coil answers very well the voltmeter shunt. Knowing the resistance of the voltmeter and drop coil, the joint resistance is obtained by dividing the product of the two by the sum of the two. For example, a 5,000 ohm meter shunted with a 200 ohm coil, the joint resistance would be 192 ohms; 1,000,000÷5,200=192. With a lower resistance meter it would be necessary to use a higher resistance coil as, for example, a 500 ohm meter and a 350 ohm coil would give a joint resistance of 206 ohms; 175,000÷850=206. For all general purposes about a 200 ohm joint resistance is most satisfactory.

Having obtained the resistance of the voltmeter with shunt the next step is to make the scale read directly in ohms. For example, if the voltmeter has a scale reading from 0 to 40 volts through dry cells are connected to give as nearly as possible a 35 volt reading with a short at the test plug. If the face of the scale is large enough the ohms may be marked directly upon it with pencil or ink.

When measuring an unknown resistance the distance in volt from 0 to the needle represents the joint resistance of the voltmeter and shunt, while the distance from the needle to the reading of the meter on a short at the plug represents the resistance to be found.

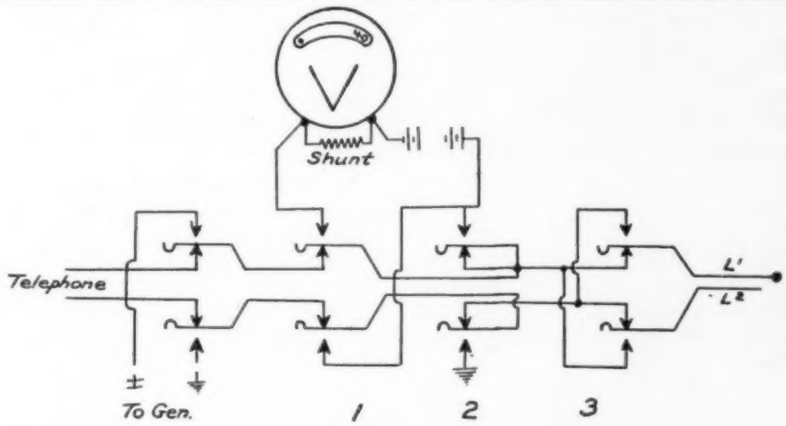
For example, if in measuring a case of trouble the needle stands at 15 volts, 15 represents the voltmeter resistance and from 15 to 35 or 20 represents the resistance to the trouble. Then 20÷15=1.33. 1.33×192 ohms=255 ohms, (assuming that the joint resistance of voltmeter and shunt is 192 ohms). This represents the resistance in ohms to the trouble. Assuming the needle stood at 8 volts, 8 would represent the voltmeter resistance and 27 the trouble. 27÷8=3.37. 3.37×192 ohms=647 ohms. Likewise assuming the needle stood at 30, then 30 would represent the voltmeter resistance and 5 the trouble. 5÷30=.166. .166×192 ohms=32 ohms. In this manner the resistance may be calculated in 1 volt or even ½ volt steps. If there is any doubt as to the accuracy of the instrument it may be checked with a known resistance and if the work is carefully done, the results will be surprisingly close.

In testing grounds the same method is applied, the resistance shown on the scale being the resistance from the office to the ground. The resistance from the ground back to the office being so slight it may be neglected in nearly all cases. Let us assume that on testing a line the meter shows a 290 ohm short. Taking 70 ohms as an average mile of circuit for No. 12 iron the trouble would show to be a little over 4 miles out. It is true there will be a slight error due to the bells across the line but this may be neglected. In locating the short it may be found to be only two miles out and that the additional 150 ohms of resistance was in the short itself due to rust or possibly a high resistance joint in the line. There is, however, a satisfaction in knowing that 4 miles is the greatest possible distance the trouble could have possibly been.

A short with no resistance at the trouble can be invariably located to within a half mile and sometimes even closer. The same holds true of grounds with the exception that but one wire is used, consequently every 35 ohms represents a mile instead of 70 ohms as in the case of the short circuit.

A crossed wire is measured in the same way as a ground with the exception that the wire with which it is crossed is grounded at the office. It is therefore necessary to take 70 ohms per mile as testing current flows out on one wire and back on another. This method of measurement may be applied to other gauges of wire where the resistance per mile is known.

It is sometimes quite difficult to locate a ground where the trouble man is not equipped with a test set to locate direction. In this case a very good test is made by having a short placed on the line by the trouble man, and testing each side of the line to ground. If the same reading is obtained in each case, the ground is beyound the place where the line is short circuited. If on the next test one side



Short - Key 1
Grd L' - " 1 and 2
Grd L² - " 1, 2 and 3

Fig. 1

shows 315 ohms and the other side 385 ohms the troubleman has passed beyond the trouble, a distance of 70 ohms or the equivalent of one mile of No. 12 iron wire. This is clearly shown by the sketch in Figure 2.

The condition of the line may also be checked by having a short and ground placed on the line at the same point. If the line is in good condition, practically the same resistance will be obage has not dropped materially and if necessary another cell should be added. If the voltage drops rapidly on this test, the batteries should be replaced. If it is desired to have a more sensitive meter for insulation tests the shunt may be wired in series with a single contact key and may be removed when necessary by throwing the key.

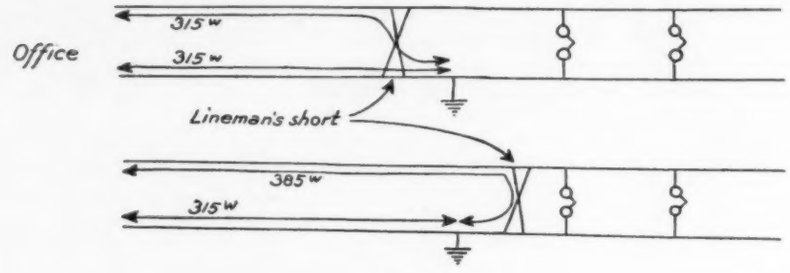


Fig. 2

BELL STORY UNTRUE

Widow of Inventor Denies That He Was Much Annoyed by Telephone

Cleveland, Ohio.—At the meeting of the Telephone Pioneers of America, General John J. Carty read some very interesting correspondence from the widow of Dr. Alexander Graham Bell, which shattered the tale that the inventor of the telephone was provoked by the ubiquitous character of the telephone bell. Dr. Bell had 9 telephones in his residence at Washington.

Mrs. Bell's letter stated:

"Dear Mr. Carty:

"I am beginning to get distressed over the many statements the papers have been publishing of Mr. Bell's dislike of the telephone.

"Of course, he never had one in his study. That was where he went when he wanted to be alone with his thoughts and his work. The telephone, of course, means intrusion by the outside world.

"And the little difficulties and delays often attending the establishment of conversation in even well managed telephone circuits did irritate him, so that as a rule he preferred having others send and receive messages. But all really important business over the telephone he transacted himself.

"There are few private houses more completely equipped with telephones than ours at 1331 Connecticut Avenue. There was nothing that Mr. Bell was more particular about than our telephone service here. For nearly all of the thirty-five years we have been here he saw personally to its proper working. We never could have come here in the first place, or continued here but for the telephone which kept us in close touch with doctors and neighbors and the regular telegraph office.

"He saw to it that we should be able to reach that at any time day or night. It was owing to this telephone system that we were able to come and stay up here this summer. Our physician lives sixty miles away in Sydney. I myself called him up at half-past five a. m. that last day; he answered immediately and all through that day the telephone served Mr. Bell faithfully and well, bringing to him one then another whom he called for. Afterwards the telegrams from all over came pouring in day and night, telephoned over without delay or mistake.

"It even accomplished what seemed almost impossible the reaching of Mr. Charles Bell at Megantic Camp, Me. There were relays, of course, but it was done by telephone—not from one big city to another, but from one isolated country station to another—from Canada to the United States.

"Mr. Bell did like to say in fun, 'Why did I ever invent the telephone?' but no one had a higher appreciation of its indispensableness or used it more freely when need was — either personally or by deputy. And he was really tremendously proud of it and all it was accomplishing. He appreciated the honor of being the first to talk from New York to San Francisco, was awed by the wonder of its performance at that dinner at the New Willard, followed with interest its usefulness during the War and the development shown at Arlington last autumn.

"Mr. Bell's one regret about the telephone was that his wife could not use it, or follow his early work in sound. I honestly believe this had much to do with his not going on with the photophone experiments and engaging instead in aerial work, the progress of which I could see as well as he.

"I shall always be so thankful that the telephone worked so well that last day—serving its father so loyally.

"Yours very sincerely,

"August 24, 1922.

"Mabel G. Bell."

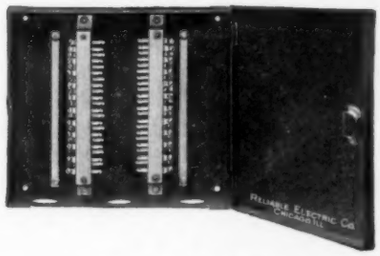
Radio Phone May Assist in Mine Rescue Work

(From U. S. Bureau of Mines)

Washington, D. C.—Tests conducted at the experimental coal mine of the Bureau of Mines at Bruceton, Pa., hold out the hope that wireless waves may be used in the future as a means of effective communication between rescuers on the surface and miners entombed in mines following fires and explosions. The preliminary experiments, while failing to develop any practical method of using wireless waves for underground communication, nevertheless indicate clearly that electromagnetic waves may be made to travel through solid strata. In the Bruceton experiments, signals were heard distinctly through fifty feet of coal strata, although the audibility fell off rapidly as this distance was increased. The absorption or loss of intensity with distance is very great for the short wave lengths used in these tests. The mine telephone has been perfected to such an extent that it is giving satisfaction in most mines where the wiring is well insulated. Very often the telephone cannot be depended upon on account of falls of rock, grounding due to worn insulation or extreme dampness. In the event of a disaster it frequently happens that the mine telephone system is put out of commission by the agency that causes the disaster, at the time when it is most urgently needed. On this account the mining industry is interested in any kind of telephone system that can be counted upon in an emergency.

STEEL BUILDING BOXES
FOR TELEPHONE DISTRIBUTION

Cable Wires Soldered



Telephone Wires Under Binding Posts

Type E—22 Pair
(All sizes up to 200 pairs)

Type E: Equipped with treated maple strips with tinned brass connectors driven through holes in maple.

Type L: Equipped with milled hard rubber strips, with brass connector bolted in place.

Reliable Electric Company

3145 Carroll Avenue :: CHICAGO, U. S. A.

WIRE TABLES (HH-25-24)

INSULATED MAGNET WIRE PER LAYER

TURNS PER INCH. The following table gives the number of turns of wire per linear inch of winding per layer. The total number of turns is equal to the number of turns per inch multiplied by the length of the layer in inches.

Size of Wire	NUMBER OF TURNS PER LINEAR INCH OF LAYER						
	Double Cotton Covered	Single Cotton Covered	Double Silk Covered	Single Silk Covered	Enamel Covered	Enamel and S.S.C.	Enamel and S. C. C.
18	20.3	22.3	22.6	23.6	24.0	22.9	21.7
19	22.5	25.1	25.4	26.8	27.2	25.8	24.2
20	24.4	27.4	27.8	29.5	30.1	28.4	26.5
21	27.4	30.8	30.8	32.8	33.6	31.5	29.6
22	30.0	34.1	34.1	36.6	37.7	35.0	32.7
23	32.7	37.6	37.6	40.7	42.3	39.0	36.1
24	35.6	41.5	41.5	45.3	47.2	43.1	39.7
25	38.6	45.7	45.7	50.3	52.9	47.9	43.7
26	41.8	50.2	50.2	55.7	59.0	52.8	47.8
27	45.1	55.0	55.0	61.7	65.8	58.1	52.1
28	48.5	60.1	60.1	68.3	73.9	64.4	57.0
29	51.9	65.5	65.5	75.4	82.2	70.6	61.9
30	55.5	71.3	71.3	83.1	92.3	77.9	67.4
31	59.1	77.3	77.3	91.6	103.0	85.3	72.8
32	62.7	83.7	83.7	101.0	116.0	93.9	79.1
33	66.3	90.3	90.3	110.0	130.0	103.0	85.6
34	69.9	97.0	97.0	120.0	145.0	112.0	91.7
35	73.4	104.0	104.0	131.0	164.0	123.0	98.8
36	76.9	111.0	111.0	143.0	182.0	133.0	105.0
37	80.3	118.0	118.0	155.0	206.0	146.0	113.0
38	83.5	126.0	126.0	168.0	235.0	157.0	120.0
39	86.7	133.0	133.0	181.0	261.0	172.0	128.0
40	89.7	140.0	140.0	194.0	290.0	184.0	134.0

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TELEPHONE ENGINEER

COMPILED BY
J. B. RATHBUN

HH-25-24

STATE MEET PEPPY

Pennsylvania Association Proves Telephone Industry Is a Virile One

Harrisburg, Pa.—Approximately three hundred persons, vitally interested in one way or another in the telephone business, gathered in Harrisburg on January 11 for a three-day convention. The meeting was the third annual gathering of the Pennsylvania State Telephone & Traffic Association.

The meeting was probably the "peppiest" yet held and it seemed to be the general opinion of those who attended that they got a lot of good out of the conference. Officers were elected as follows:

H. E. Bradley, of Harrisburg, president, re-elected; C. A. Carl of Lancaster, vice president eastern division; K. B. Schotte, of Kittanning, vice president western division, and C. L. Baer, of Harrisburg, secretary and treasurer. Members executive committee, H. E. Bradley, C. A. Carl, K. B. Schotte, E. M. Prisk of Hazleton, and J. H. Wright, of Meadville.

The directors are: H. E. Bradley, E. M. Prisk, J. F. Stockwell, Philadelphia; C. L. Baer, C. A. Carl, G. B. Rudy, York; E. D. Schade, Johnstown; J. H. Wright, K. B. Schotte, J. Z. Miller, Erie; and W. S. Paca, Oil City.

The personnel of the resolutions committee included: E. M. Prisk, E. D. Schade, C. A. Carl, A. O. Black, of Butler, and W. S. Paca.

Fred B. MacKinnon, president of the United States Independent Telephone Association, read a paper on "The Two Groups in the Telephone Industry." In this paper he pointed out the grounds of contact between the independents and the Bell organizations.

G. S. Call, chief of the bureau of accounts and statistics of the Pennsylvania public service commission, spoke on the remarkable growth and development of accounting in the telephone industry and the changing methods. "The smaller public service companies twenty years or so ago," he said, "used to keep its records on the backs of envelopes and on check stubs." He added:

"Accurate accounts are necessary to find out the financial condition of a company and to find its financial progress in order that justifiable rates may be levied that will not be excessive and yet bring a fair return to the people that have their money invested in the industry."

The problem of accidents was taken up by James J. Lewis, district manager of the Utilities Mutual Insurance Co., and Ralph Bloomsburg, safety engineer for the company. Mr. Lewis said that 98 per cent of the accidents were caused by some sort of inefficiency.

W. S. Vivian, manager of the department of public relations of the Automatic Electric Co., of Chicago, had charge of the operators' sessions which attracted much interest. Papers were read on various problems of the work.

Prof. N. C. Miller, of the department of engineering extension, Pennsylvania State College, spoke on "Employe Training." He announced a correspondence course now available to telephone company employes.

Resolutions were passed as a result of the deaths of James C. Kelsey and T. J. Schufflin. Mr. Kelsey will be remembered for his interesting department conducted in TELEPHONE ENGINEER up to a short time before his death.

SHORTS

Officials of the New York Telephone Co. predict that by 1930 there will be 2,000,000 telephones in operation in New York City.

* * *

For every stockholder in the American Telephone & Telegraph Co. in 1900 there are now thirty. That is important. It shows an enormous increase in investors in public utilities.

But the chief point is this—every investor is a friend. And friends are needed.

* * *

It is claimed by the Clarendon Telephone Co., of Clarendon, Tex., that in that town there is one telephone to every three inhabitants. But that doesn't mean so many telephones.

* * *

Isolated farmers, unable to get telephone service, are again being urged to band together and build their own lines. The advice comes from the U. S. department of agriculture. It is working in the right direction.

Toll Line in Wyoming Planned at Cost of $70,000

Sheridan, Wyo. — The Mountain States Telephone Co. is planning to build a toll line between Gilette, Wyo., and Sheridan this year. It is estimated that the cost will be about $70,000. Efforts will be made to complete the line by August 1.

GRAHAM IS CHIEF

Arkansas Telephone Association Elects Clarendon Man Its President

Little Rock, Ark.—W. M. Graham of Clarendon, was elected president of the Arkansas Telephone Association at the two-day meeting, which closed here on Jan. 16. Other officers elected are: J. E. Armstrong, Russellville, first vice president; T. L. Evans, Atkins, second vice president, and George Walker, Sheridan, secretary.

The closing day program was featured by a demonstration at the local telephone office of the new automatic switching machines. Percy Redmund of St. Louis, manager for Arkansas and Missouri of the Southwestern Bell Telephone Co., spoke on the importance of good service to telephone patrons.

Thomas Stahl, of Siloam Springs, served as president last year. The program was as follows:

Jan. 15

Call to order, Thos. Stahl, president.

Invocation, the Rev. Harry G. Knowles, Little Rock.

Address of Welcome, Ben D. Brickhouse, mayor, Little Rock.

Response, L. M. Emerson, Prescott.

Address, Earl Hodges, Little Rock.

Address, Percy Redmund, St. Louis, Mo.

"Trial, Troubles and Tribulations of a Small Town Manager," John Shaffer, Gentry.

"Telephone Problems for 1923," F. B. Sprague, Corning.

"Benefits of District and Annual Meetings," Geo. Walker, Sheridan.

"Accounting for Small Companies," W. J. Moore, Harrison.

Jan. 16

"Radio and Its Application to Commercial Communication," M. M. Huston, St. Louis, Mo.

"Developing the Rural Telephone," C. C. Watson, Monette.

"Legal Problems," W. M. Graham, Clarendon.

"The Benefit of Co-operation," L. L. Evans, Atkins.

Address, E. B. Downie, Little Rock.

Copper Clad Steel Co. Issues Data on 'Phone Wire

Rankin, Pa.—The Copper Clad Steel Co., of Rankin, maker of "Copperweld" telephone wire, has issued technical data sheets and wire tables which will be of interest to telephone managers and construction men. The data shows the relative values of different kinds, and gauges of wire—dealing with weight per mile, breaking strain, resistance, speech transmission characteristics and such other points as go toward keeping down maintenance costs. The per mile weight data present an interesting comparison.

Waterloo, Ia.—M. W. Ricker, division traffic supervisor of the Bell company here, has been promoted to district traffic chief.

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Dr. W. F. Smith, Head of Mexican Phone System, Dead

Somerville, Mass.—Dr. William French Smith, president of the Mexican Telephone & Telegraph Co., of Mexico, since 1905, died at his home here on Feb. 2. He was a graduate of Harvard. Dr. Smith had been engaged in chemical and metallurgical research work for many years in addition to his telephone company duties.

Flu Causes Telephone Exchange to Suspend

Columbus, Tenn.—An epidemic of influenza which has swept this district forced the temporary suspension of telephone service in the Santa Fe community in Maury county. All of the girls at central were stricken.

Telephone TALKS

No. 1

VOLTAGE

FOR years it was rather difficult to interest telephone companies in a low amperage dry cell for telephone service.

It required concerted effort by battery manufacturers to educate the telephone buyer to the fact that on infrequent service, the lower the amperage the longer the life, everything else being equal.

Naturally, amperage became the yardstick for measuring a dry battery's efficiency. The matter of voltage was shoved in the background. In fact is was taken for granted that each cell should produce 1½ volts, no more, no less.

Then, along came a higher voltage dry cell that revived interest in another factor. It proves that when two dry cells of equal amperages, varying slightly in voltage, are placed side by side in service, the cell with the higher voltage outlasts the lower voltage cell.

It all reverts to the fact that under conditions which mean exhaustion to the low voltage cell, the cell with the high voltage is still able to function because the pressure is sufficient to overcome all resistance existing when the amperage has dropped below the usual cut-off point.

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Bartlett Tree Trimmers are standard with leading telephone and telegraph companies.
Write for prices and literature.

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BACK ISSUES WANTED

Several copies of Jan., Feb. and Sept., 1922, and February, March, April, May, June and July, 1921, issues of TELEPHONE ENGINEER are needed for files of telephone companies. We will extend subscriptions two months for each issue supplied us.

TELEPHONE ENGINEER
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CHICAGO

Nally to Direct International Radio Relations

Edward J. Nally, president of the Radio Corporation of America, has been elected to the new office of managing director of international relations and will assume the leadership of the corporation's activities in foreign fields. Cooperating with leaders of wireless abroad he will take up the work of creating and operating international radio communication in all parts of the world. Major General James G. Harbord succeeds Mr. Nally as president of the Radio Corporation.

George F. Bell Quits 'Phone Work to Sell Insurance

Tulsa, Okla.—George F. Bell, manager of the district office of the Southwestern Bell Telephone Co., at Tulsa, has resigned to become associated with the Pacific Mutual Life Insurance Co. He entered the telephone business in Kansas seventeen years ago. He will be associated with H. C. Pollock under the name of Pollock & Bell.

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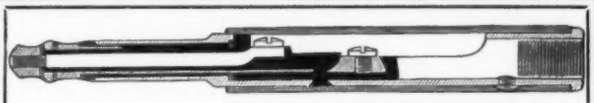

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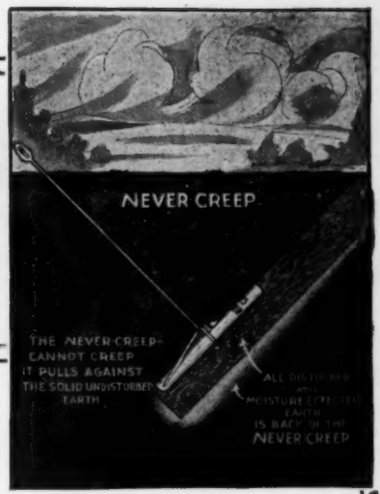
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The Thimbleye is the first and only great improvement that ever has been made in the eye of a guy rod. It preserves the cable, and makes installation easier.

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The Never-Creep is bolted against the solid earth—it doesn't have to pull against disturbed earth.

No big pit is necessary, no channel has to be cut, and there is no creeping or skidding.

Installation is quickly and easily made. It is impossible to install a Never-Creep wrong.

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CHANCE COMPANY

ANCHORS PROTECTORS BRACKETS
SOCKET WRENCHES BACK TRUSSES

CENTRALIA, MO.

(Continued from Page 23)

set, provided he prepares himself for this service.

Many of the principles of radio receiving sets are already familiar to the telephone man. He is familiar with the process of holding back direct current and passing alternating current by means of a condenser and the similar one of holding back alternating current and passing direct current by means of inductance. He also has some understanding of the phenomena of resonance as exemplified in harmonic ringing systems, although, properly speaking, this is mechanical rather than electrical resonance.

A well informed telephone man has only to extend his knowledge to include high frequency phenomena and the theory of the vacuum tube in order to complete his knowledge of the fundamentals underlying radio apparatus. His past experience in telephone apparatus will enable him to judge of the mechanical excellence of such apparatus.

In subsequent articles, radio phenomena will be discussed from the standpoint of the telephone man reviewing such portions of the telephone art as is of value in explaining the theory, design and operation of radio apparatus. An elementary knowledge of electricity will be assumed. Mathematics will be confined to simple algebra and practical examples will be given where design of apparatus is involved.

As early as 1885 experiments were made in England by stretching two parallel wires a quarter of a mile apart. By charging one, a response in the other could be obtained.

In 1887, Professor Hertz, of Germany, made an extensive research into the propagation of electric waves through space, using a static machine and detecting the response by means of the spark across the gap of an open loop. He determined, by experiment, that these waves traveled through space at the speed of light.

Prof. E. Branly, of Paris, France, in 1890 invented the coherer for detecting the Hertzian waves in space. This device consisted of a glass tube having an electrode at each end, with the space between the electrodes filled with metal filings. The filings became more conductive to electric current under the influence of the wireless wave.

In the year 1895, Marconi demonstrated that the waves could be produced by means of high frequency oscillations, set up by means of a high tension spark and that they could be transmitted through the earth, water or air. The following year, he was able to send and receive signals at a distance of three miles and six years later was able to transmit telegraphic signals across the Atlantic Ocean.

Dr. Fleming, in 1902, invented the first vacuum tube used in radio communication. This, however, only employed two elements and was inefficient, compared to the present day three-element tube.

Between 1902 and 1906, the high frequency alternater and arc system of producing electric waves were developed and, in 1906, Dr. Lee De Forest, produced the three element tube used at the present time in sending, receiving and amplifying radio waves.

All the above cases refer to radio telegraphy but already Fessenden and others were experimenting with voice transmission, the great difficulty being in producing a pure wave of a single frequency for sending. In 1908, Prof. Marjorana was enabled to send the voice for 300 miles by means of a special arc generator and liquid microphone.

This method was, however, more of a laboratory than a commercial system and it was not until 1915 when the American Telegraph and Telephone Co., in conjunction with the Western Electric Co. demonstrated the possibility of telephoning from Arlington to Paris and to Hawaii, the latter a distance of 5,000 miles, that the world awoke to the possibilities of the radio phone.

Startling as these demonstrations were, no one would have ventured to predict that the time would come when they would be as common as the phonograph and in practically every home.

The war did much to develop the system and under the stimulus of the public interest its use is now growing by leaps and bounds.

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FOR SALE—Sterling and Ericsson switchboard apparatus of all kinds; also Corwin inter-communicating. We do repairing, rewinding, etc., on all makes of telephones and switchboard apparatus.—**Corwin Electric Co.**, Lafayette, Ind.

East Haven Telephone Co. to Be Taken Over Soon

New Haven, Conn.—The New England Telephone Co. will soon take over the East Haven Telephone Co., if plans which have been worked out become effective. The East Haven company has about 400 subscribers.

New Phones at Scranton, Pa., Equipped with Dials

Scranton, Pa.—All new phones being installed here are equipped with dials. However, they will be operated in the usual way. The dials are merely preliminary to later switching over to the automatic system.

Galesburg Company Putting Its Wires Underground

Galesburg, Ill.—The Galesburg Union Telephone Co. expects to have the most of its wires underground within the next few months. G. B. Churchill is president.